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PROGRESS REPORT

of the

✓
MARKET QUALITY RESEARCH DIVISION✓
AGRICULTURAL RESEARCH SERVICE

This progress report includes a summary of the current research of the Division and a preliminary report of progress made during the preceeding year. It is primarily a tool for use of scientists and administrators in program coordination, development and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of progress on USDA and cooperative research include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting results of USDA and cooperative research issued between July 1, 1967, and June 30, 1968. Current agricultural research findings are also published in the monthly USDA publication, Agricultural Research. This progress report was compiled in the Market Quality Research Division, Agricultural Research Service, United States Department of Agriculture, Hyattsville, Maryland.

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UNITED STATES DEPARTMENT OF AGRICULTURE

Hyattsville, Maryland 20782

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INTRODUCTION

The research of Market Quality Research Division is concerned with the measurement, improvement, and protection of the quality of agricultural commodities in marketing channels. The work encompasses physiological, biochemical, pathological, and entomological problems encountered during the storage, transport and distribution of agricultural commodities, and the development of new methods and devices for evaluation of quality.

Market Quality Research Division is a part of the Agricultural Research Service. It is headquartered at Hyattsville, Maryland. The greatest concentration of its scientific personnel is at Beltsville, Maryland, which includes the Instrumentation Research Laboratory, Color Research Laboratory, Postharvest Physiology Pioneering Research Laboratory, and personnel of Field Crops and Animal Products Research Branch and Horticultural Crops Research Branch. There are 25 field stations located throughout the country; 11 are located at State universities or branch experiment stations and two in terminal markets. Total research effort, including research contracts, amounts to about 168 scientist man-years.

Although a large variety of excellent quality fresh and processed agricultural products are retailed at reasonable prices throughout the year, there is need for further research on methods to reduce spoilage and waste during storage, transportation and distribution, and to improve methods to reduce spoilage and waste during storage, transportation and distribution, and to improve methods for evaluation of quality. Stored product insects and market diseases still destroy large amounts of produce regardless of costly controls. There is urgent need for new methods of control that will not create health hazards due to pesticide residues. Automated objective methods of quality evaluation are increasingly needed to make possible rapid reliable grading and inspection of large quantities of produce under modern packing, handling and transporting conditions.

An appreciable amount of the Division's research is related to the effective performance of the service divisions of the Consumer and Marketing Service and the regulatory and control divisions of the Agricultural Research Service responsible for standardization, inspection and grading of agricultural commodities. Market Quality Research Division also works closely with industry and other Government agencies on various problems relating to agricultural commodities in the marketing channels. Specific examples of research accomplishments by the Market Quality Research Division over the past five years are:

Improved method for determining neutral oil loss in crude soybean oil

A chromatographic method has been used by the American Oil Chemists' Society and the National Soybean Processors Association for determining the neutral oil loss in crude soybean oil. Although this method was not as accurate as desired, it was used in price settlement. Upon request of the American Oil Chemists' Society, Field Crops and Animal Products Research Branch initiated research which resulted in a revised method that increased accuracy by 25%. The method has been accepted and was used officially by the National Soybean Processors Association during the past season. Further improvements made by the Field Crops and Animal Products Research Branch during the past year were unanimously accepted by the American Oil Chemists' Society Technical Committee for use during the coming season. The revised method will allow the operator to complete one-third more analyses per unit of time than the old method. Also, the tests can be carried out in non-air conditioned laboratories which was not possible with the old method.

Lighting for meat grading

A survey of 56 meat packing establishments throughout the United States indicated considerable variation exists in intensity and quality of light and other environmental conditions under which beef is visually evaluated in coolers. As a result of this survey, research was undertaken to determine the quality and intensity of light most suitable for visually evaluating meat in coolers. Evaluation of excised rib samples under incandescent and fluorescent lights of 15 to 100 foot candles indicated that fluorescent light of 50 foot candles or less minimized the discernable amount of marbling. Incandescent light of at least 50 foot candles appeared necessary to accurately display the natural cherry red color of fresh meat. When sides of beef were evaluated in coolers illuminated with incandescent, "Cool White" fluorescent, or "Optima" fluorescent lights, the beef observed under "Cool White" appeared more mature than when examined under the other 2 light sources. By increasing intensity of the light from 5 to 30 foot candles the carcasses appeared lighter red and were rated as being less mature.

New test for seed vigor

When a farmer or gardener buys seeds, the analysis on the label assures him that the seed is alive and will germinate but gives no assurance that seedlings will develop into strong, healthy plants. Differences in germination rate and weaknesses due to low vigor or seed injuries persist through the growing season and cause reduced yield or differences in maturation date. The increasing use of a single destructive mechanical harvest for many crops makes uniformity of maturation date an important seed quality factor. Studies of seed vigor have shown that respiration of germinating seeds is related to their potential for rapid germination and growth. Vigorous seeds take up oxygen more rapidly and have lower respiratory quotients (carbon dioxide evolution/oxygen uptake) than non-vigorous seeds. In some cases, vigorous

and non-vigorous lots can be distinguished by respiration tests within 60 minutes. A wide variety of types of injury in many different kinds of seeds can be detected. This finding has provided the basis for a practical test for seed vigor. The respiration test has the following advantages over presently used germination and cold tests: greater sensitivity, results can be obtained within hours rather than days, more easily standardized, and less laborious to perform.

Instrument for rapid nondestructive evaluation of interior quality of fruits and vegetables

A four-filter photometer has been developed for measuring the absorption properties of intact fruits and vegetables at four selected wavelengths. This instrument has demonstrated the ability to measure the maturity of green tomatoes, internal color of ripe tomatoes, maturity of apples, presence of internal browning in apples and potatoes, and presence of water core in apples. The photometer is especially useful since it can detect a defect and evaluate maturity at the same time.

Evaluation of textural properties of fruits and vegetables

A new technique for nondestructive evaluation of firmness of fruits and vegetables has been developed. The sample is set into vibration by applying sonic energy and the frequency for maximum vibration (the resonant frequency) of the object is determined. This resonant frequency correlates well with subjective evaluation of firmness (firm apples have a higher resonant frequency than soft apples). The technique has been applied to a number of fruits and vegetables and appears to have general applicability.

Phosphine as a fumigant for stored product insects

Phosphine was first proposed as a fumigant only for grain. Research by the United States Department of Agriculture provided the performance data that led to the establishment of a Food and Drug tolerance and label registration for that purpose by USDA. The fumigant was found to have many favorable qualities such as relative safety to operators during application, ease of handling and application, a high degree of toxicity to insects at rather low concentrations, excellent penetrating power, rapid aeration, and the deposition of very little or no residue. As a result of further USDA research the material now is also used to fumigate stacks of commodities under plastic covers, empty or loaded rail cars, and as a space fumigant in mills. The product has gained extensive use in industry and in 1968 was adopted for use by the Armed Forces to protect subsistence items. Recent research indicates that phosphine appears to be a promising fumigant for tobacco in warehouses. It penetrates the tobacco more readily than other fumigants, insuring complete kill of insects even in the center of hogsheads.

Dichlorvos for insect control in warehouses

Equipment was developed and patented to vaporize and dispense dichlorvos as a space treatment in warehouses. Extensive laboratory and field studies established the dosage requirements and procedures for application. Residue data obtained were submitted to the Food and Drug Administration and tolerances were established in 1968. A commercial firm is preparing to manufacture the dispensers. The Armed Forces and the food industries are anxiously awaiting the equipment so they can begin to use the treatment. Dichlorvos will fill a serious gap in the ability to control insects in warehouses. Previous materials that could be used safely were expensive and not highly effective. Other potential materials could not be used because of toxicity or residue considerations. The dichlorvos vapor treatment leaves only a low level of relatively short lived residue. It is anticipated the progress thus far will lead to other uses in the food and feed industries. Earlier research had developed a dichlorvos aerosol treatment that has gained extensive use in tobacco warehouses. Refinement of application procedures and much additional data were required before dichlorvos could be used where food and animal feed were present.

Diseases of stored product insects

Little attention had been paid to the diseases of stored product insects until a research program was initiated in 1966. In two years a great deal has been learned about the microorganisms that infect these insects under natural conditions. About 35 species of infective agents have been found. Many were previously unknown to science. Laboratory studies indicate about 30 of the species are highly pathogenic to the insects. These findings provide a foundation for extensive research that remains to be done. Much must be learned about the pathogens themselves, their relationships with the insects, and ways in which the diseases can be used as control measures. It is typical that these organisms are rather specific in action and do not infect mammals. This offers the potential of a safe way to reduce the annual loss of over one billion dollars in the United States inflicted by stored product insects.

Air shipment of strawberries

In 1967 the volume of California strawberries shipped by air was more than double that moved by rail and far exceeded any previous year's total. Of more than 1,900 carlot equivalents, 116 went to foreign markets. During the 1965-67 period many accompanied air test shipments were conducted by personnel of the Fresno laboratory and 6 were made to Europe during 1966-67, 2 of which were accompanied. Valuable information has been obtained on materials and methods for maintaining favorable temperatures and atmospheres and much progress made in the development of refrigerated and insulated containers for maintaining quality of fresh fruits and vegetables. Tests are continuing with emphasis on export shipments. Three publications have been issued and findings on protective covers, containers and improved handling methods are being widely applied by the airlines.

Ozone treatments

In the recent past, ozone generators have been widely promoted, sold, and leased on the basis of claims for control of wastage in fresh fruits and vegetables during storage, ripening, and transportation. As a result of numerous inquiries from handlers of fruits and vegetables, a series of experiments to evaluate ozone were conducted during 1965, 1966, and 1967. These tests showed that ozone at recommended concentrations did not reduce postharvest decay in peaches, strawberries, blueberries, cantaloups, green beans, or grapes held under refrigerated or room conditions. Ozone also failed to reduce wastage in tomatoes during ripening. At higher concentrations (0.5 p.p.m. and above) it caused drying of strawberry caps and surface injury to green beans and peaches. Surface growth of mold was inhibited at 0.5 p.p.m. and higher, but the organisms continued to grow within the tissues. As a result of the 3 publications reporting this research the industry has saved substantial sums of money by evaluating the claims of ozone benefits in the light of the published data.



AREA 1

CITRUS AND SUBTROPICAL FRUITS - MARKET QUALITY

Handling, Transportation and Storage

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years, F.Y. 1968		
	Research Problem Area		Total
	404	501	
<u>Citrus fruit other than limes</u>			
California	3.0		3.0
Texas	0.2		0.2
Florida	4.0	1.0	5.0
Total Citrus	7.2	1.0	8.2
<u>Avocados, mangos, limes and papayas</u>			
Florida	0.5	0.5	1.0
Total sub-tropical fruit:	0.5	0.5	1.0
<u>Total</u>	7.7	1.5	9.2

Intramural program is supplemented by extramural support representing (a) 0.3 SMYs at State Experiment Stations^{1/} and (b) P.L. 480 funds in 3 countries totaling 185,127 U.S. dollars equivalent.

^{1/} RPA 404 0.3

Problems and Objectives

The production and marketing of U.S. citrus fruits, avocados, and mangos is a billion dollar industry. Despite the substantial progress of recent years in bulk handling from the orchard, smaller shipping containers, and improved refrigerated transport, costly losses occur in the markets from decay, physical damage, and rind disorders. Such losses in the market are magnified by the costs of packing, transporting, and selling fruit, some of which is unsuitable for consumer use.

Major objectives of the research are to develop and evaluate alternative ways for:

1. Developing objective quality indices and automated sorting.
2. Reducing decay and functional disorders.
3. Maintaining product quality through mechanized harvest.
4. Extending marketing season through fruit storage.

Progress - USDA and Cooperative Program

RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS

A. Quality Maintenance in Storage

1. Controlled atmosphere storage of Florida citrus fruits. Valencia oranges stored in 15% O₂ + 0% CO₂ at 34° F. retained a better flavor than fruit stored in other CA conditions or in air. Fruit stored in CA developed more aging than fruit stored in air. Panel taste tests after 4 months' CA and air storage did not show consistent flavor ratings. Alternaria citri decay was present after storage, although not externally visible, and imparted severe off-flavors to the fruit.

Storage of Marsh grapefruit for 2 to 3 months at 50°, regardless of fungicidal or storage treatment, including CA storage, resulted in 13 to 80% decay.

Unwaxed Temple oranges stored for 5 weeks in 15% O₂ + 5% CO₂ at 40° F. retained excellent flavor but storage for 10 weeks caused a loss of most of the characteristic Temple aroma.

At harvest, Temple orange juice averaged 0.006% ethyl alcohol which increased to 0.114% in unwaxed fruit and 0.203% in waxed fruit after 5 weeks in 5% O₂ at 40° F. Alcohol production during storage was increased by a prestorage application of wax, reduction of O₂ during storage, and length of storage period. (HC-41)

2. Controlled atmosphere storage of Arizona lemons. Arizona lemons stored at 57° F. for 6 months were in marketable condition, with respect to decay, with less than 1% decay. The fruit lost from 10 to 15% in weight

depending upon packinghouse treatment. Lemons stored in 10% oxygen without added CO₂, under the same conditions were greener, showed less weight loss, and were equal in flavor to fruit stored in air. (HC-45)

3. Controlled atmosphere storage of Texas grapefruit. Development of rind pitting in December harvested red grapefruit was affected more by carbon dioxide levels in the atmospheres than by oxygen. Pitting was severe on fruit held in atmospheres in which carbon dioxide was absorbed from the start of CA storage and in atmospheres in which it was reduced to zero from an initial level of 5%. In contrast, fruit from atmospheres in which carbon dioxide was reduced to 2.5% from an initial level of 5% showed only a trace of pitting. Fruit stored immediately in 45° F. air developed more pitting than that cured 3 days at 70° before storage at 45° (1.0% vs. 0.1%).

The incidence of surface browning resembled closely the pattern for rind pitting. It was most prevalent on fruit held in carbon dioxide free atmospheres and occurred the least on fruit from atmospheres with 2.5% carbon dioxide. Fruit stored immediately at 45° F. in air showed more surface browning than fruit cured 3 days at 70° before storage at 45° (19.3% vs. 3.4%).

Decay was more severe in the lots of fruit in which pitting was prevalent. Decay in the individual lots of fruit after 15 weeks ranged from zero (four lots treated with #1991) to 60%. Fruit treated with DuPont #1991 before storage averaged 8.8% decay while the controls showed 28.2%. (HC-35)

Retention of harvesttime peel color was best in fruit held in 2.5% oxygen. Internal quality of all CA lots was acceptable. Peel color was not affected by carbon dioxide levels. (HC-35)

4. Controlled atmosphere storage of Florida avocados, mangos, limes, and papayas. Avocados stored in static and constant flow systems with 1% O₂ + 10% CO₂ at 50° F. developed severe decay. The primary diseases were Colletotrichum, Dothiorella, and possibly Diplodia. The decay developed after 30 days' storage in air, and after 45 and 60 days in CA storage.

Limes stored in 7% O₂ + 10% CO₂ and 5% O₂ + 7% CO₂ at 50° F. retained acceptable peel color after 30-, 45-, and 60-days' storage but juice content was reduced to an unacceptable level. Storage of limes in CA at 40° resulted in severe rind scald which did not develop at 50°. Storage of limes at 50° in atmospheres containing 15% CO₂ resulted in rind injury.

Storing mangos in several CA atmospheres at 50° F., to reduce stem-end decay, resulted in slight to severe chilling injury after 20 days in storage.

Papayas stored for 3 weeks in 1% O₂ + 5% CO₂ at 55° F. developed slight decay. Fruit stored in air and other modified atmospheres developed moderate to severe decay. (HC-38)

5. Citrus volatiles as a measure of storage quality of lemons. Volatiles emanated from green and yellow lemons with and without added ethylene were measured by gas chromatography. Production of total volatiles by lemons was increased by treatment with ethylene. Ethylene-treated green lemons produced more than twice as much total volatiles as ethylene-treated yellow lemons. More than 20 gas chromatographic peaks were detected in volatiles emanating from ethylene-treated green lemons. Nine of these were tentatively identified as α -pinene, camphene, β -pinene, β -myrcene, d-limonene, γ -terpinene, terpinolene, neral, and geranial. (HC-47)

B. Quality Maintenance During Transportation

1. Export shipments of California citrus fruits. Average fruit transit temperatures of 36 orange test shipments were 44° to 57° F.; 9 lemon tests 46° to 55°; and 6 grapefruit tests 47° to 64°. Nearly all biphenyl residues in lemons and grapefruit were below the Common Market tolerance of 70 parts per million. Residues in oranges exceeded tolerance in 3 to 81% of the lots, depending on handling procedures and total temperature pattern. (HC-48)

2. Export shipments of Texas red grapefruit. A containerized shipment of Texas red grapefruit was transported over the highway to Houston and then by special container ship to Rotterdam during the period January 5-27. Cooling of the fruit during transit was slow due primarily to short-circuiting of air from the cooling unit and to a faulty load pattern. Fruit temperatures were satisfactory at market arrival and fruit condition generally satisfactory. (HC-37)

C. Postharvest Physiology

1. Maturation and ripening of avocados. This research under P.L. 480 in Israel has developed information on the identification and action of endogenous growth regulators in avocado tissue. Fruit tissue cultures are grown in artificial media which enables numerous replicated tests of ripening response on sections of mesocarp tissue. (HC-65 (A10-MQ-2))

2. Metabolic changes during storage and ripening of mangos. This P.L. 480 research is underway at the University of Baroda in India. Basic information has been developed on enzyme activity, ethylene synthesis, and carotene increases during postharvest ripening. Some evidence has been developed that susceptibility to chilling injury in mangos can be reduced by surface waxing or gradual increase of exposure to 5° to 10° C. over a period of several days. (HC-63 (A7-MQ-6))

D. Postharvest Disease Control

1. Control of decay of Florida citrus fruits. Five new fungicides were evaluated for control of citrus decay. DuPont #1991, 1-(butylcarbamoyl)-2-benzimidazole carbamic acid, methyl ester, a systemic, (500 ppm) was superior to the other fungicides. Throughout the season this fungicide

controlled all decay except Alternaria on all varieties when applied pre-harvest and prior to inoculation with Penicillium. The fungicide, 5-aceto-8 hydroxy-quinoline-sulfate (1%), was effective but disagreeable to use. Three remaining fungicides were ineffective. Degreening and color-add treatments of Murcott Honey oranges severely increased decay and rind injury without improving the appearance. In CA storage tests, no combination of O₂ or CO₂ which maintained fruit quality prevented decay. (HC-42)

2. Materials affecting germination and growth of decay organisms. The solubilities of five aldehydes which inhibit germination of Penicillium were: valeraldehyde 0.413 M, hexaldehyde 0.113 M, heptaldehyde 0.0094 M, octanal 0.0043 M, and nonanal 0.00056 M. The concentrations (M x 10³) required to give 50% or more inhibition ranged from 2.5 to 0.04, respectively. As fumigants, valeraldehyde and heptaldehyde were more effective than the other aldehydes tested. (HC-44)

3. Effects of modified atmospheres on growth of decay organisms. Decay rates, sporulation and soilage of lemons and Valencia oranges inoculated with Penicillium digitatum were reduced as oxygen concentration in the storage atmosphere was lowered. Lemons were stored at 56° F. and oranges at 42°. Fungus sporulation was severely restricted at 2% O₂, and fungal growth was only scanty at 1% and absent at 0% O₂. Inoculated fruit removed to air decayed normally. (HC-46)

4. Losses in oranges during marketing. Marketing losses of Navel oranges averaged 4.5% in the New York metropolitan area and almost 7% in the Chicago market. Florida Valencia oranges averaged 4.6 and 5.6% loss, respectively, in the New York and Chicago markets. Losses were caused principally by green mold with smaller losses from Alternaria and physical damage.

5. Antimicrobial action of biphenyl. Research on this P.L. 480 project in Germany has covered physiological responses of a yeast, a bacterium, and 2 fungi to biphenyl and sodium orthophenylphenate. Response to the chemical varied with the organism tested. Neither the yeast nor the bacterium was inhibited by biphenyl but both were slowed by SOPP. Both materials showed specific action on the fungi. The action of biphenyl was fungistatic whereas SOPP was fungicidal. Resistance to both chemicals developed with prolonged exposure. Furthermore, exposure to either chemical ultimately developed resistance to the other. Evidence was developed as to the specific enzyme systems inhibited. (HC-67 (E10-AMS-3))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Degreening Response of Oranges. Studies on the degreening response of oranges in closed chambers indicated that the optimum level of ethylene for maximum color change was between 5 and 10 ppm. No injury appeared to result from ethylene concentrations as high as 2%. Increasing the oxygen level in the chambers from 10 to 50% caused the degreening rate to increase slightly. This response was generally not apparent when ethylene was present. Delaying

effects of low oxygen and temperatures of 70° F. on degreening disappeared rapidly in storage indicating that aeration and higher temperatures may not be needed for good color development. (HC-43)

2. Seasonal Changes in Florida Persian Limes. Limes originating from bloom set in April and harvested 163 days after bloom were approximately 5% higher in juice content than January-set fruit harvested after 163 days. Limes from the January bloom had slightly higher citric acid content and a higher percentage of rind by weight.

Limes harvested in November from 7 rootstocks were held for 3 days at 106°-110° F., and the amount of induced styelar-end breakdown ranged from 77 to 98%. Additional fruit harvested the next month and held for 3 days at 100° developed from 0 to 6% styelar-end breakdown. (HC-39)

3. The Detection of Additives in Citrus Juices. Continuation of this P.L. 480 project in Spain has developed additional analytical tools for detection of adulterants in citrus fruit juices. Rapid and accurate determination of the carboxylic acids by gas-liquid chromatography has been developed. The finding that the proportion of saccharose to monosaccharides does not change with storage, heat treatment or SO₂ additions provides an additional possible tool for detection of additives. (HC-66 (E25-AMS-6))

Publications - USDA and Cooperative Program

RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES

Quality Maintenance in Storage

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RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

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AREA 2

DAIRY PRODUCTS - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years F.Y. 1968					Total
	Research Problem Area					
	412	501	702			
Maryland (Beltsville)	1.0	0.5	0.5		2.0	
Wisconsin (Insects)	1.0				1.0	
Total	2.0	0.5	0.5		3.0	

Intramural program is supplemented by extramural support representing (a) 0.6 SMYs at State Agricultural Experiment Stations 1/, (b) 0.5 SMYs at other U.S. institutions 2/, and (c) P.L. 480 funds in one country representing 7,855 U.S. dollars equivalent.

1/ RPA 412 0.6

2/ RPA 412 0.5

Problems and Objectives

Several kinds of insects and mites may contaminate dairy products, especially nonfat dry milk and cheese during processing, storage and distribution. Safe and effective methods of prevention or control are needed. Average annual losses of nonfat dry milk due to insect contamination during 1951-60 were about \$400,000, in spite of more than 1½ million dollars spent annually on control. Based on a 20% increase in production of dairy products in the next 12 years, a 50% reduction in losses of dry milk through improved insect control would save \$250,000 annually by 1980. A reduction of 25% in the cost of control would save an additional \$375,000. Similar reductions for other dairy products would produce additional savings. Dairy products in marketing channels are also subject to deterioration by microbiological action and by oxidative processes.

Major objectives are to:

1. Reduce losses caused by dairy-product insect damage and contamination.
2. Develop control procedures that will reduce or eliminate insecticide residues.
3. Develop new approaches of control through better knowledge of biology and ecology of the insects.
4. Improve tests for estimating initial quality and for maintaining quality.

Progress - USDA and Cooperative Programs

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

1. Moisture Distribution in Butter. Preliminary observations indicate that even high-quality butter stored at -20° C. is subject to severe surface oxidation when stored in prints and would be downgraded from grade AA to grade B in 7 to 8 months. All print butter stored 7-8 months at 3° C. was below original grade. No evidence of microbiological growth was observed in any of the samples. Electrical resistance in all samples was > 2,500,000 ohms. (FC-89)

2. Heat Stability of Bacteria. Psychrophilic bacteria apparently killed by heating (0 plate count) at 55° C. for 30 minutes appear to recover under certain conditions. The same has been reported with a variety of Salmonella. A series of experiments showed that trypticase (pancreatic digest of casein) in the heating medium enabled recovery of sublethally-heated psychrophilic bacteria. This same recovery occurs in cold-sterilized whey, a system closely resembling raw milk. These results imply that simple enumeration of viable survivors in heat resistance studies is not meaningful unless the possibility of recovery is considered and ruled out experimentally. (FC-88)

3. Biological and Physical Control of Insect Infestation. The synthetic black carpet beetle sex attractant, trans-3, cis-5-tetradecadienoic acid, was tested under field conditions. Preliminary tests indicate the attractant, which is relatively stable, was effective for several days over short distances when used alone or over greater distances when used in combination with air circulation or a black-light. The attractant showed good stability in deep-freeze storage. (SP-7)

In quantitative bioassays with the cigarette beetle sex attractant, 50% of exposed males responded to 0.0003 female equivalents of the attractant. The attractant retained biological activity after nearly a year in deep-freeze storage, and has survived preliminary chromatographic purification. Improved bioassay techniques were developed. (SP-7)

Interspecies testing among several Trogoderma species indicated that T. inclusum and T. glabrum responded to an extract of T. granarium (khapra beetle) females. In preliminary tests in Israel the males of T. granarium responded to the extracts of female T. inclusum and T. glabrum. The khapra beetle males responded faster to the T. inclusum extracts than they did to extracts of khapra beetle females. (SP-7)

Further laboratory tests were conducted with the synthesized sex attractant of the black carpet beetle, trans-3, cis-5-tetradecadienoic acid. As little as 0.0001 µg of the synthetic compound elicited responses by male insects. The other three isomers (cis-3, trans-5; cis-cis; and trans-trans) were synthesized. These were less active than the trans-3, cis-5 compounds. More importantly, their presence in a mixture did not interfere with the activity of the trans-3, cis-5 compound, which means that a practical large-scale synthesis should be possible since the difficult separation of isomers is not necessary. One sequence for large-scale synthesis of the synthetic material is under investigation. (SP-4 (C7786))

The sex attractant of T. inclusum was isolated by the following procedure: benzene extraction, distillation, sodium bicarbonate extraction, low temperature precipitation, silica gel chromatography, and gas-liquid chromatography. Fifty thousand processed females yielded 0.3 mg. of active material. Isolation of the sex attractant of T. glabrum is proceeding along the same route. Preliminary work indicated that the attractant material is similar to that of T. inclusum. (SP-1 (C9500))

Pheromone(s) of the cigarette beetle remained biologically active after deep-freeze storage for nearly a year. Preliminary chromatographic isolation procedures proved successful, and the activity of various fractions was confirmed by laboratory bioassay. (SP-71 (A9785))

In detailed studies of the internal anatomy of the black carpet beetle, no apparent structures for housing or aiding microbial symbionts were found. No intracellular forms were seen and no apparent mutualistic micro-organisms

were present. The life cycle was determined for a protozoan common in the larva. The addition of sorbic acid to the diet of mated pairs of either the black carpet beetle or Trogoderma parabile at levels of 1.2-8% by weight during the full development of that generation resulted in failure of progeny to survive beyond the 1st larval instar. (SP-5 (A8475))

The biological significance of the constituents of cheese that attract insects is under study. Minute amounts of a cheese constituent that attracts the cheese mite have been extracted. Attractivity was concentrated in the neutral, noncarbonyl, and alcoholic fraction, from which a 3,5-dinitrobenzoate derivative of the attractant was isolated. Lyophilization of the cheese may yield greater quantities of attractant. (SP-42 (All-MQ-3(a)))

4. Improved Insecticidal Control. The effect of surfaces of various building materials on the residual toxicity of malathion to the black carpet beetle is being investigated. Malathion applied to vinyl tile, clay brick or cement surfaces was not toxic to the black carpet beetle larvae. Malathion was evaluated for effectiveness on various coating agents. One g. of malathion/m² was ineffective on all surfaces tested. Two g. of malathion/m² was effective for at least 20 weeks on the talc and calcium carbonate coatings, but not on the others tested.

Several oils were toxic to black carpet beetle larvae on nonporous surfaces. The oils showing toxicity included vegetable, mosquito larvicidal, and crop-spraying oils. (SP-6 (A9391))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Analysis of Feeds and Forages for Chlorinated Pesticide Residues.

Studies were continued to develop methods for the extraction and cleanup of chlorinated pesticide residues in various types of livestock feeds and forages. Blending samples with chloroform-methanol mixtures appears to give better recovery in some cases than blending with the mixture of isopropyl alcohol and hexane. Good recoveries are obtained during rapid cleanup on carbon-celite and partially inactivated Florisil. (FC-86)

2. Electrophoretic Patterns of Soluble Proteins in Bacteria. Washed suspensions of gram-negative bacteria were treated ultrasonically to disrupt the bacterial cells and the soluble proteins released were separated by electrophoresis on cellulose acetate strips. Patterns obtained from 18 species of Salmonella were virtually identical and readily distinguishable from those obtained from coliforms. However, Pseudomonas species patterns were similar to those obtained from Salmonella. While the cellulose acetate strips are readily stained to identify proteins, nucleic acids and nucleoproteins, the patterns obtained are light and not of uniformly high quality. Further work is needed to obtain clear and reproducible patterns. The use of cellulose acetate strips is much faster than other electrophoretic procedures. (FC-115)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICRO-ORGANISMS
AND NATURALLY OCCURRING TOXINS

1. Inhibition of Salmonella and Other Bacteria by Essential Oils. An investigation was begun of the bacteriostatic and bactericidal properties of some essential oils and chemical constituents of essential oils. Orange oil at 1,000 p.p.m. was found to be bacteriostatic for a large number of gram-negative and gram-positive bacteria but its bactericidal properties were variable. Several terpenes which are known constituents of essential oils were also evaluated. α -Terpineol proved most effective. It was not only bacteriostatic, but at 1,000 p.p.m. killed all Salmonella in test cultures (5×10^7 bacteria/ml.). Suspensions of the oils were used which had been dispersed ultrasonically. Addition of 0.1% orange oil to creamed cottage cheese increased the shelf-life from 3 to 7 days at 30° C. and from 1 to 2 weeks at 3° C. (FC-102)

Publications - USDA and Cooperative Program

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

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- Burkholder, W. E. 1967. Response of the male black carpet beetle, Attagenus megatoma (Fabricius), to the female-produced pheromone, with notes on other species. Diss. Abs., Sect. B, 28(2):725B. (SP-7)
- Dunkel, Florence V. and Boush, G. Mallory. 1968. Studies on the internal anatomy of the black carpet beetle, Attagenus megatoma. Annals of the Ent. Soc. Amer. 61(3):755-765. (SP-5)
- Silverstein, Robert M., Rodin, J. Otto, Burkholder, Wendell E., and Gorman, John E. 1967. Sex attractant of the black carpet beetle. Science 157(3784):85-87. (SP-4)
- USDA, ARS. 1968. Protecting home-cured meat from insects. Home and Garden Bul. 109. (SP-7)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

- Dobres, H. L. and Moats, W. A. 1968. Qualitative analysis by thin-layer chromatography of some common dyes used in biological staining. Stain Technol. 43:27-30. (FC-87)
- Moats, W. A. and Dabbah, Roger. 1968. Improved nonmechanical method for estimating dispersibility of nonfat dry milk. J. Dairy Sci. 51:607-610. (BS-3-61)

AREA 3

DECIDUOUS FRUITS AND TREE NUTS - MARKET QUALITY

Handling, Transportation, and Storage

USDA and Cooperative Program

Location of Intramural Work	Scientist Man Years F.Y. 1968		
	Research Problem Area		Total
	404	501	
<u>Deciduous Tree Fruits</u>			
Washington	2.0	1.0	3.0
California	1.0	0	1.0
Maryland (Beltsville)	3.5	2.0	5.5
New Jersey (market)	1.0	0	1.0
Chicago (market)	2.0	0	2.0
Total Deciduous Fruit:	9.5	3.0	12.5
<u>Grapes and Berries</u>			
California	1.5	0	1.5
Maryland (Beltsville)	0.5	0	0.5
North Carolina	0.2	0	0.2
Total Grapes & Berries:	2.2	0	2.2
<u>Dried Fruits</u>			
California (Insects)	3.0	0	3.0
<u>Tree Nuts</u>			
California (Insects)	2.0	0	2.0
Total	16.7	3.0	19.7

Intramural program is supplemented by extramural support representing (a) 0.9 SMYs at State Agricultural Experiment Stations^{1/}, (b) 0.3 SMYs at other U.S. institutions^{2/}.

^{1/} RPA 404 0.9

^{2/} RPA 404 0.3

Problems and Objectives

Deciduous tree fruits, grapes and berries vary in perishability and deteriorate at different rates after harvest. Market losses vary from about 15% in strawberries to an average of only 2 or 3% in pears. Reduction of these losses by half would save millions of dollars, improve market supplies of these essential foods, and decrease retailer and consumer resistance to these perishable items.

Losses of dried fruits and tree nuts caused by stored-product insects in marketing channels averaged \$16.5 million annually during the years 1951-1960 in spite of the \$4 million spent each year on insect control. Improved control treatments that would reduce losses by one-third and the cost of control by 25% would effect an annual savings of over \$6 million by 1980.

Major objectives of the research are to develop and evaluate alternative ways for:

1. Objective measurement and sorting by internal quality.
2. Controlling decay and functional disorders.
3. Storing fruits under optimum environments.
4. Reducing losses caused by stored-product insects.
5. Improving insect control procedures and reducing residues.

Progress - USDA and Cooperative Program

RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES

A. Quality Maintenance in Storage

1. Controlled atmosphere effects on apples. Eastern-grown Red Delicious and Golden Delicious apples stored 6 months at 32° F. in atmospheres maintained by a commercial generator were no firmer on removal and in several instances were softer than fruit stored in air. The CA room atmosphere had an average concentration of 5-6% oxygen and 2% carbon dioxide. Under the conditions the oxygen burner was not able to maintain the 2% oxygen level desired for these varieties in a small Mylar-lined room. Leakage of exhaust fumes from the generator into the CA storage is believed to have hastened softening.

Sealed polyethylene carton liners used for shrivel control of Golden Delicious resulted in severe suffocation or low-oxygen injury and winey fruit in the CA room. Perforated film liners with an overlap closure gave good protection from moisture loss in both air and CA storage. (HC-1)

2. Controlled atmosphere storage of western nectarines. The most favorable atmospheres for storing nectarines at 31° F. were those with 2.5 to 5% carbon

dioxide. Increased carbon dioxide with air or with 2.5% oxygen was equally effective for maintaining quality. Dessert quality of the fruit after 8 weeks' storage in atmospheres with carbon dioxide was judged good. Excessive decay developed in all lots after 11 weeks' storage. (HC-56)

3. Controlled atmosphere storage of eastern peaches. Three varieties of peaches stored for 6 and 9 weeks at 32° F. decayed less rapidly in atmospheres of 1% and 21% oxygen with 5% carbon dioxide than in air. Peaches tended to lose their flavor more rapidly in air than in the other atmospheres. Taste panelists preferred peaches of each variety which had been stored in the 1% oxygen-5% carbon dioxide atmosphere to those stored in air or other modified atmospheres. Peaches harvested early in the season at a firmness of 14.5 pounds kept slightly better in all atmospheres than peaches of the same variety harvested at later dates when the firmness had dropped to 12.1 or 10.8 pounds. Graininess, often severe in peaches held 6 and 9 weeks at 32° in air, was markedly reduced in peaches held in atmospheres of 1% or 21% oxygen with 5% carbon dioxide. Peaches held in air at 32° for 6 weeks had a higher respiration rate when transferred to 65° than peaches held in 1% or 21% oxygen with 5% carbon dioxide. (HC-3)

4. Controlled atmosphere storage of strawberries. Strawberries held at reduced oxygen levels (1/2% or less) for 36 hours at 60° F. had less botrytis decay than those kept in air, but off-flavors developed. Most tasters could not distinguish between berries held in 1% O₂ and those held in air but decay was not significantly reduced. These effects were observed immediately after storage and after an additional 24 hours in air at 60° F.

Strawberries exposed to carbon dioxide levels of 20% and 30% at 60° F. for 36 hours developed less decay after an additional 24 hours in air than those held in air the entire time. Tasters preferred the berries that had been in 20 to 30% carbon dioxide to those held in air. (HC-27)

5. Storage of Chinese gooseberry (*Actinidia chinensis*). Fruits of *Actinidia chinensis*, which is becoming a commercial crop in California, were harvested at 5 weekly intervals beginning November 21 and were stored at 32° F. for 4, 8, or 12 weeks. At removal from storage and after 1 or 2 weeks at 60° F. light reflectance, resistance to deformation, soluble solids, and pH were determined on individual fruits. The internal color changed from green to greenish-yellow at the later pickings, and with increased ripening time, but did not change appreciably during storage. Resistance to deformation decreased at the later picking dates, with longer storage time, and with longer ripening time. Soluble solids and pH both increased at the later picking dates, and increased slightly during storage and ripening. Storage life and market quality will be reported later. (HC-68)

6. Storage of new pear varieties. A study was initiated, under cooperative agreement with the University of Maryland, to determine optimum harvest dates, storage environments, and storage period for 2 blight-resistant pear varieties (Magness and Moonglow) now being planted in eastern states. Flesh firmness

and total acids decreased at each of 3 pickings, about 10 days apart. All of the fruits ripened unevenly when ripened immediately after harvest. After 1 month's storage at 32° F. ripening within a lot was quite uniform. Decay was not serious after 2 months' storage, but rather serious at the end of 3 months. Internal breakdown developed after 3 months' storage and did not seem to be related to time of harvest. The fresh and processed quality of sound fruit was satisfactory after 3 months' storage at 32° and ripening at 65°. (HC-58)

B. Quality Maintenance During Transportation

1. Air shipment of California strawberries. Domestic air shipping tests. Strawberry temperatures averaged about 46° F. in pallets with sealed fiber-board covers and about 49° F. in open pallets in air shipping tests made during the spring, summer, and fall seasons. Relative humidity in the cabin of the jet freighter averaged about 3%. Atmospheres in the sealed pallet covers with added carbon dioxide averaged about 12% CO₂ and 15% O₂ in covers with a fold-strap seal and 8% CO₂ and 16% O₂ in covers with a taped seal. Decay averaged about 5% of berries in the sealed pallets and 8% of berries in the open pallets after a holding period of 1 day at 60° F. at the market.

Export tests. Strawberries shipped from Southern California to London by jet airfreighter were about 21 hours in transit at temperatures ranging from 47° to 62° F. Fruit temperatures in an insulated container increased only about 5°, while the temperature of fruit carried open in the cabin of the plane increased 15°. Atmospheres in sealed pallet covers with added CO₂ had CO₂ levels near 15%. Practically no decay developed in this lot of berries, but over twice as many soft, overripe berries occurred in fruit carried outside the container. (HC-27)

C. Postharvest Physiology

1. Scald control for eastern apples. The extensive commercial use of non-sealed polyethylene liners to control shrivel of Golden Delicious apples has resulted in more scald development following long storage. The antioxidant ethoxyquin ("Stop-Scald") used as a 10-second prestorage dip in 70° F. water at 2700 ppm gave excellent control of scald on Golden Delicious apples with no skin injury in 3 tests. A 20-second dip in 130° water gave good control in only 1 of the 3 tests with Golden Delicious. Scald development on Golden Delicious in non-sealed polyethylene was appreciably less in CA than in air storage in only 1 of 3 tests.

Scald on Red Delicious and Stayman varieties of the 1967 crop was light, possibly due to the cool weather prior to harvest. Use of CA storage, rather than conventional air storage, did not consistently reduce scald development. Both of the approved chemical dip treatments (2000 ppm diphenylamine and 2700 ppm ethoxyquin) gave good scald protection but diphenylamine was better for the Delicious variety. In 2 of 3 tests, a 5-minute dip in 120° F. water before storage gave better scald control, without injury, than use of

diphenylamine or ethoxyquin. Treatment for 20 seconds in 130° water caused skin injury on Delicious. Good control of scald on Stayman apples, in this light scald season, was obtained by treatment 2 weeks after harvest with either diphenylamine, ethoxyquin, or 20 to 30 seconds in 130° water. (HC-2)

2. Scald control for western apples and pears. Less storage scald developed on commercially waxed Starking Delicious apples than on untreated fruit. DPA applied in wax or as a spray on the fruit just before waxing produced no further scald reduction. DPA wraps on waxed fruit reduced scald about the same amount as a DPA spray applied immediately after harvest.

Experimentally waxed fruit developed slightly more scald than checks, and almost twice as much as commercially waxed fruit. The main difference in the two methods of application was the use of heat to dry the fruit in the commercial operation. This suggests partial control of scald by heating the fruit.

Submersion of Anjou pears in water at 125° and 130° for 3 minutes or 135° for 2 minutes controlled both scald and blue mold rot.

Ethoxyquin applied in sprays, wraps, or waxes, controlled scald on Golden Delicious apples and Anjou pears. Ethoxyquin applied as a spray just before waxing reduced scald on Anjou pears. (HC-54)

3. Effects of preharvest environment on postharvest quality of apples.
Controlled bloom. Delicious apples from trees induced to bloom by artificial cooling or warming at 4 different dates were harvested at 135, 145, and 155 days from their respective blooms. After 7 to 8 months' storage, the firmest fruit and that with the highest soluble solids was from the earliest bloom and these values decreased in fruit from each later bloom date. The titratable acidity followed the same pattern at harvest but after storage, the differences in acid content were small.

Fruit harvested at 155 days from the early blooms developed storage scald while water core was found in the fruit from the 2 later blooms.

Shape of the fruit was more elongated from the two early blooms, but external color was better on fruit from the last two bloom dates.

Fruits harvested at 145 days from bloom regardless of bloom date, were usually rated best in an organoleptic evaluation. The exception was the latest bloom date where fruit harvested at 135 days was rated best.

Natural bloom. General indications are that Red Delicious from orchards which bloomed after the middle of May developed better color in the same period from bloom than fruit from earlier orchards. Storage scald development was not related to bloom date. Fruits from late blooming orchards, harvested 155 days from bloom, were the only ones with any water core. Soluble solids varied by orchard although all fruit from the late orchards had high solids.

Soluble solids and acid in Golden Delicious varied by orchard and may be influenced more by nutrition than environmental factors. Fruits from the late-blooming orchards were relatively high in solids and acid and fruit from these orchards harvested 155 days from bloom were slightly firmer than those from early bloom. However, breakdown developed in this fruit and not in that from the early blooming orchards. (HC-55)

4. Effects of preharvest environment on postharvest quality of pears. This work done in the Hood River Valley under cooperative agreement with the Oregon Experiment Station showed clearly that Bartlett pears maturing on artificially cooled limbs softened and colored prematurely as compared with pears on limbs at ambient temperatures. During the 7- to 21-day preharvest cooling period citric acid decreased markedly in the cooled pears, but increased in the controls. Both quantitative and qualitative changes occurred in amino acids in the cooled pears and respiratory activity was higher in the cooled fruit. The normal pattern of metabolism during maturation was substantially changed by maintaining day temperatures at 60-65° F. and night temperatures at 36.4° as compared with fruit exposed to ambient temperature. (HC-57A)

5. Effects of pesticides on storage quality. Research under this P.L. 480 project in Finland has shown that postharvest application of the growth regulator CIPC resulted in significant increases in reducing sugar in plums and reduction of B-carotene content in tomatoes ripened after harvest. Additional tests, both preharvest and postharvest, will be made with these and other fresh fruits to determine the physiological basis for these effects. (SP-43)

(E8-AMS-6(a))

D. Postharvest Disease Control

1. Heat treatment for table grapes. Emperor grapes that had been treated with hot water (115-118° F.) for 10 minutes before storage had about 30% as much decay as non-heated lots after 10 weeks in storage at 32° F. Fungicides (manzate, botran, and thiabendazole) applied as a dip reduced decay an additional 10 to 15%. Without heat, the fungicide treated lots had 60 to 70% as much decay as the non-treated lots. The grapes were not injured by the treatments, but none of the treatments were as effective as the standard sulfur dioxide fumigation. (HC-28)

2. Decay control for strawberries. The "half warming" times of strawberries decrease with increasing air flows at least up to 20 cfm/lb. of fruit. More consistent and uniform reduction in decay with moist heat has occurred at high air flows. With more rapid heating at the higher air flows, exposure time must be reduced to avoid injury. At 107-108° F. and low flow rates (4-6 cfm/lb. of fruit), 40-45 minutes exposure was required for effective decay control; at high flow rates (15-20 cfm/lb. of fruit), 25-30 minutes exposure was equally effective. Very ripe berries seem to be more susceptible to heat injury than berries at optimum shipping maturity. Decay was not controlled as well on very ripe fruit as on less ripe fruit. During simulated air shipment (36 hr. at 60° F. ambient), the most effective postharvest treatment for strawberries was to (a) maintain berry temperature at 35° F. Next

in order of effectiveness were: (b) Heat pasteurization (108° F. for 30 min.), (c) maintaining a 1% O₂ atmosphere, (d) 20% CO₂, (e) a 0.5% DHA dip for 15 seconds, and (f) a 2500 ppm Captan dip for 15 seconds. All the above treated berries had less decay than an untreated check held at ambient temperature.

In 6 tests with field-infected strawberries, postharvest dip treatments with Dupont Chemical 1991 and Geigy Chemical 20072 failed to reduce decay (mostly botrytis) during 4 days at 60° F. Exposure to 110° F. air for 30 or 60 minutes with high relative humidity reduced decay of these berries by over 50%. Respiration rates of the heated berries was somewhat lower than that of non-heated ones. (HC-28)

3. Heat treatment of peaches. Peaches inoculated with Monilinia fructicola and non-inoculated peaches heated in 125° F. water for 2½ minutes developed considerably less brown rot during 6 and 9 weeks' storage in CA at 32° and during ripening in air at 65° than comparable non-heated peaches. Heat-treated Red Globe peaches sprayed with Captan shortly before harvest developed severe black to tan mottle. The injury was more pronounced after 9 weeks than after 6 weeks of storage. Heat-treated Redskin peaches which were not sprayed with Captan before harvest did not show severe heat injury until after 9 weeks of storage. Heat injury was less severe on peaches stored in air than those stored in 1 or 21% oxygen with 5% carbon dioxide.

Electron microscopic studies showed that the internal content of germinated Rhizopus stolonifer and Monilinia fructicola spores are severely damaged by heating the spore in 125° F. broth for 2½ minutes. The nuclei of heated germinated Rhizopus spores are either destroyed or broken into fragments. The heat treatment, though preventing further elongation of germ tubes of Monilinia spores, did not destroy the nuclei in the spore or their germ tubes.

4. Heat treatment of figs. Surface mold and rhizopus rot of Black Mission figs were greatly reduced by pasteurization in moist hot air at 116° F. for 30 to 60 minutes. After 3 days at 65° F., about 1/5 as much mold and decay developed in treated as in the untreated lots. In taste tests, most tasters could not distinguish between heated and non-heated figs. Pasteurization is most effective on figs that are not fully ripe.

Rhizopus rot and surface mold of Kadota figs were reduced by 1 hour exposure to moist air to a temperature of about 115° F., which did not change the flavor or texture of the fruit. Development of decay was delayed for 1 or 2 days, but was not prevented by the treatment. (HC-28)

5. Effects of atmosphere modification on growth of certain fungi. The mycelial growth of 5 commonly occurring decay fungi decreased linearly with decreasing O₂ concentrations below 4%. At 4% O₂ growth of Botrytis cinerea, Cladosporium herbarum, Alternaria tenuis, and Fusarium roseum was 44-55% of that in air, and that of Rhizopus stolonifer was 85% of that in air.

When Botrytis, Alternaria, Fusarium, and Cladosporium were grown in atmospheres of 2% O₂, growth was stimulated by the addition of low concentrations of CO₂. Peak stimulation occurred with the addition of 4% CO₂ for Alternaria and Fusarium, 8% CO₂ for Botrytis, and 16% CO₂ for Cladosporium. CO₂ at all concentrations depressed the growth of Rhizopus stolonifer.

When O₂ levels were normal (20% O₂), the growth of all fungi tested except Fusarium decreased linearly with increasing CO₂ and 50% inhibition occurred at 20-23% CO₂. Fusarium was stimulated by up to 20% CO₂ and 50% inhibition occurred at 45% CO₂.

Germination of Rhizopus and Cladosporium spores was inhibited by about 50% CO₂ in atmospheres of 1% O₂. Germination of Alternaria, Botrytis, and Fusarium spores was significantly inhibited only at atmospheres of 0.25% O₂ or less.

High CO₂ atmospheres also inhibited spore germination, with 50% inhibition of Botrytis and Cladosporium occurring at 16% CO₂, and of Rhizopus at 2% CO₂. Germination of Alternaria and Fusarium was only slightly inhibited by 32% CO₂. (HC-30)

6. Radiation effects on pathogenicity of fungi. Virulence of auxotrophic mutants of Penicillium expansum is related to the presence and availability of growth promoting amino acids in the host tissue and/or to the production by the fungus of anti inhibitors to overcome the host's defense mechanism. An avirulent beige colored, acriflavine resistant mutant of P. expansum which required leucine and nicotinic acid for growth was obtained after ultra-violet light radiation treatments. In apple tissue, reversions for the leucine requirement resulted in the restoration of virulence. In vitro, methionine inhibited the growth of the mutant when the molar concentration ratio of methionine to leucine was at least $8.5 \times 10^{-4}M$: $2.3 \times 10^{-4}M$ respectively. None of the methionine analogs tested reversed the inhibition. In apple fruit, however, growth and virulence of this mutant was obtained in decreasing amounts by the addition of either leucine, ethionine, methionine, sulfoximine, arginine or after mechanical bruising.

Auxotrophic and streptomycin resistant mutants of Erwinia carotovora were produced either by UV treatment (450 ergs/mm^2) or by the mutagen N-methyl 1 N-nitro-N-nitrosoguanidine (MNNG-250 ppm for 30 min.). No mutants were obtained from among 6,000 survivors of UV treatment that had lost their ability to produce pectolytic enzymes. This would indicate the presence of more than one gene locus controlling the production of more than one pectolytic enzyme. (HC-22)

7. Composition of blueberries as related to postharvest decay. Tests with blueberries harvested from two locations at weekly intervals again showed that varieties high in acid develop less decay. Sugar contents may have a minor influence. Analysis of the 1967 data produced a correlation of +.892 between percent decay and soluble solids:acid ratios. Postharvest decay in

Wolcott and Jersey blueberries was associated with large size and with high light transmittance difference meter readings within a size. (HC-51)

8. Proteolytic enzymes in death of fruit tissues. Botrytis cinerea and Botryosphaeria ribis did not produce a detectable protease in infected apple tissue when tested by the casein digestion method (measurement of tyrosine liberated). However, a more sensitive viscosity assay (gelatin substrate) did reveal protease activity in diseased apple tissue infected with each of these fungi.

Limited efforts to improve the methods of extracting diseased tissue were made. Vacuum infiltrating polyethylene glycol, a phenol-complexing agent, into the diseased tissue did not improve enzyme recovery in limited attempts.

A conidial isolate of Glomerella cingulata produced an active protease in diseased apple. Activity was strong in both the casein hydrolysis and gelatin viscosity assays. (HC-17)

9. Identification of market diseases. Apples. Moldy carpels and core rots have been observed in Red Delicious apples from Virginia and Washington. Apples from Virginia were more affected than those from Washington. Eighty one percent of 485 fungal isolates recovered from moldy cores were identified as Alternaria tenuis. In addition the following fungi were isolated: Leptosphaeria, Rhizopus, Cladosporium, Fusarium, Penicillium, Tricothecium, Pleospora, and Hormodendron sp. A relationship between open core and decay was noted. (HC-18 & 23)

10. Losses in fruits during marketing. Apples. Red Delicious apples from the Northwest averaged about 4% loss through consumer levels in the New York market and 14% in the Chicago market. Bruise damage accounted for most of the loss. Appalachian Delicious apples averaged slightly less market loss in the New York City market.

Peaches. Brown rot and bruising caused most of the losses in Southeastern peaches. Losses through the consumer level averaged more than 15 and 24% respectively in the New York and Chicago markets.

Strawberries. Over a 6-month marketing period marketing losses in California strawberries averaged more than 25% in both the New York and Chicago markets. Decay and physical damage caused most of the loss. During a 1-month marketing period losses in Southeastern strawberries averaged 22% at wholesale and retail and an additional 16% at the consumer level. Losses were principally from gray mold. (HC-19 & 24)

E. Prevention of Insect Infestation

1. Biology, ecology and physiology. Biology, ecology and behavior studies of Oryzaephilus surinamensis and O. mercator showed that temperature and food affected their rate of development, egg production, life span, preoviposition and oviposition periods. (SP-46)

Malathion did not alter the time of day at which the Indian-meal moth deposited the greatest number of eggs. Malathion-treated adults deposited greatest number of eggs on the 1st day as opposed to the 3rd day for untreated moths. Viability and greatest number of eggs produced was less for treated moths. Temperature fluctuations from 24 to 30° C. in phase with normal timing of light did not alter circadian egg production of treated or untreated moths, as was found at 27° C. A 12-hour reversal of the temperature fluctuations during a normal light cycle caused in untreated moths a secondary peak of egg production 6 hours earlier than the normal peak. A combination of malathion and reversed temperature cycle caused a 12-hour delay in the peak oviposition time on the first day. (SP-47)

Various species of nitidulid beetles have been collected from the following areas: Alabama, Arizona, California, Florida, Georgia, Hawaii, Indiana, Michigan, Mississippi, Nevada, Ohio and Mexico. Laboratory cultures have been established of Carpophilus lugubris, C. corticinus, C. californicus, C. freemani, C. marginellus, C. mutilatus, C. hemipterus, C. obsoletus, C. dimidiatus, Haptoncus luteolus, Urophorus humeralis, Stelidota geminata, Colopterus sp. Samples of the immature stages of the various species have been preserved, and microslide specimens for morphological study have been prepared. (SP-37 (A9710))

Oxygen uptake in 3 mite species increases from egg through the adult stage. Resting stages have uptake only little smaller than that of previous active stage. Uptake of mobile hypopus is smaller than that of resting protonymph.

Three species of mites common under field conditions developed with fungi as sole food, but 2 other species could not. Two of the 5 species developed on medicinal herbs, but flour mites did not develop on sterilized herbs in the laboratory. (SP-44 (E21-MQ-1(a)))

2. Improved insecticidal control. Residues on raisins dried on malathion-treated trays were influenced by maturity of grapes and temperature. More mature grapes had lower residues and raisins that had dried during warmer weather had higher residues.--Regular dosages of pyrethrins thermal aerosols did not effectively control insects in wineries.--Fifty percent of 426 dried fruit packages used by the industry became infested after 3 months' exposure to large numbers of insects.--Packaged raisins coated with vegetable oil had 47% less infestation than uncoiled raisins.--Aluminum phosphide at the rate of 5 tablets per 1,000 cu. ft. was effective against insects in commercially stocked raisins. (SP-46)

Malathion residues of less than 8 ppm protected shelled almonds from beetle damage for one year. (SP-47)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Eastern Apples. During the 1967-68 season the taste panel scored low chlorophyll apples as sorted by wavelengths Δ 0.D. (700-740 nm), significantly

higher in sweetness and flavor than apples high in chlorophyll. These results agree with those obtained in 1966-67. However, quality differences for categories sorted by wavelength Δ O.D. (580-640 nm) in 1967-68 were not as large as in 1966-67.

Although average acidity for all apples measured in 1967-68 was about the same at harvest, significant differences in acidity levels between chlorophyll-sorted categories became apparent in controlled atmosphere (CA) storage, but not in conventional storage. Overall acid loss was less in CA-stored apples. (HC-11)

2. Western Apples. Golden Delicious apples harvested on several dates and treated with 1000, 5000, and 20,000 rad of gamma radiation showed no effect of the treatment when examined in January. However, in late June, fruit harvested at 145 days from bloom was slightly but consistently firmer than the check fruit. The differences in firmness after long storage were not found in fruit harvested at 160 days from bloom. Scald on Golden Delicious was decreased in proportion to the amount of gamma radiation applied with very little scald present on fruit treated with 20,000 rads.

Preliminary examinations of the 1967-68 data indicate that the chlorophyll content of Golden and Red Delicious is related to nitrogen nutrition of the tree. Higher leaf potassium values were generally related to higher acid content of the fruit. (HC-53)

3. Red Tart Cherries. The amount of scald in the canned samples of cherries from lots held in soak tanks with 1 or 11 ppm oxygen was often much higher than the scald in frozen samples from the same lots. There was no apparent consistency in the amount of scald in the fresh, canned, and frozen fruits. The relation between oxygen or temperature of the soak water and subsequent scald development in the processed fruit was poor. Increased oxygen which was expected to decrease scald actually increased symptoms resembling scald. This suggests that the discrepancy may be due to the development of oxidative browning which was observed in one very high oxygen treatment. (Exploratory)

Publications - USDA and Cooperative Program

RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES

Quality Maintenance in Storage

- Fidler, J. C., and North C. J. 1967. The effect of conditions of storage on the respiration of apples. I. The effects of temperature and concentrations of carbon dioxide and oxygen on the production of carbon dioxide and uptake of oxygen. Jour. Hort. Science 42:189-206. (E29-AMS-1a)
- Fidler, J. C., and North C. J. 1967. The effect of conditions of storage on the respiration of apples. II. The effect on the relationship between loss of respirable substrate and the formation of end products. Jour. Hort. Science 42:207-221. (E29-AMS-1a)

Schomer, H. A., and Patchen, G. O. 1968. Effects of hydrocooling on the dessert quality and storage life of apples in the Pacific Northwest. USDA, ARS 51-24. (MQ 2-127)

Quality Maintenance During Transportation

Harris, C. M., Porter, F. M., and Harvey, J. M. 1967. Freight shipment of California strawberries in mechanically refrigerated rail cars: Test shipments--1967. USDA, ARS 51-21. (HC-27)

Harvey, J. M. 1968. USDA studies air shipments of California berries to Europe. The Packer 75(15):4B. (HC-27)

Harvey, J. M., Harris, C. M., Couey, H. M. 1968. Export of California strawberries to Europe via jet airfreighter--1966-67. Factors affecting market quality on arrival. USDA, MRR 810. (HC-27)

Postharvest Physiology

Pierson, C. F. and Schomer, H. A. 1967. Chemical and non-chemical control of Anjou scald. HortScience 2(4):151-152. (HC-54)

Salminen, Kari and Koivistoinen, Pekka. 1967. Quantitative gas chromatography of nonvolatile organic acids: Evaluation of the internal standard method. Acta Chemica Scandinavica 21:1495-1500. (E8-AMS-6(a))

Schomer, H. A. and Pierson, C. F. 1967. The use of wax on apples and pears. Wash. State Hort. Assoc. Proc. 63:198-200. (HC-54)

Postharvest Disease Control

Ballinger, W. E., Kushman, L. J., and Galletta, G. J. 1967. Relationship of fruit acids and sugars to keeping quality of blueberries. Cumberland-Shenandoah Fruit Workers' Conference, Winchester, Va., Nov. 16-17, pp. 86-88. (HC-51)

Beraha, L. 1968. A rapid method for the preparation of a semi-solid agar medium for detection of pectolytic enzyme activity in Erwinia carotovora. USDA Plant Disease Reporter 52:167. (HC-22)

Beraha, L. and Garber, E. D. 1967. Avirulence of a methionine sensitive leucine mutant of Penicillium expansum in Jonathan apples. Phytopath. 57: 803-804. (HC-22)

Brooks, J. F., Ballinger, W. E., and Kushman, L. J. 1968. Harvesting, handling, and shipping blueberries. Hort. Infor. Leaflet 201-G. (HC-51)

Pierson, C. F. 1968. Method for determining the sensitivity of fungus spores to hot water. Phytopath. 58:538-539. (HC-54)

Smith, W. L., Jr., Blomquist, M., and Baker, J. E. 1968. Effect of hot broth treatments on dormant and germinated Monilinia fructicola and Rhizopus stolonifer spores. (Abstr.) Phytopath. 58:887. (HC-4)

Smith, W. L., Jr., and Redit, W. H. 1968. Postharvest decay of peaches as affected by hot-water treatment, cooling methods and sanitation. USDA, MRR 807. (HC-4)

Spalding, D. H. 1968. Ozone storage of fruits and vegetables. USDA, MRR 801. (MQ 2-102)

- Wells, J. M. 1967. Growth and the production of pectic and cellulolytic enzymes by Rhizopus stolonifer in low oxygen atmospheres. (Abstr.) Phytopath. 57:1010. (HC-30)

Prevention of Insect Infestation

- Nelson, H. D., Spitler, G., and Yerington, A. P. 1967. Use of malathion treated drying trays to protect raisins from insects during drying and storage. USDA, MRR 789. (SP-46)
- USDA, ARS Information. 1967. Treated trays protect raisins. Agric. Res. 16(3):13. (SP-46)
- Yerington, A. P. 1967. Insects attracted to argon light traps in California wineries. Calif. Vector Views 14(8):52-54. (SP-46)
- Soderstrom, E. L., and Lovitt, A. E. 1967. A volumetric dispenser for insect media. J. Econ. Entomol. 60(4):1179-1180. (SP-47)
- Spitler, G. H., and Hartsell, P. L. 1967. Laboratory evaluation of malathion as a protectant for almonds during storage. J. Econ. Entomol. 60(5):1456-1458. (SP-47)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

- Olsen, K. L., Schomer, H. A., and Bartram, R. D. 1967. Segregation of Golden Delicious apples for quality by light transmission. Amer. Soc. for Hort. Sci. Proc. 91:821-828. (HC-53)
- Hardenburg, R. E. 1967. Wax and related coatings for horticultural products. A bibliography. USDA, ARS 51-15.

AREA 4

GRAIN - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	: Scientist Man-Years F.Y. 1968			
	: Research Problem Area :			
	: 408	: 501	: 702	: Total
Georgia (Insects)	: 0.3	:	:	: 0.3
Maryland (Beltsville)	: 1.3	: 5.4	: 1.0	: 7.7
Kansas	: 0.5	: 1.0	: 0.5	: 2.0
Kansas (Insects)	: 7.0	:	:	: 7.0
Total	: 9.1	: 6.4	: 1.5	: 17.0

Intramural program is supplemented by extramural support representing (a) 3.3 SMYs at State Agricultural Experiment Stations ^{1/}, (b) 5.7 SMYs at other U. S. institutions ^{2/}, and (c) P.L. 480 funds in six countries representing 269,925 U. S. dollars equivalent.

1/ RPA 408 1.3; RPA 501 1.0; and RPA 702 1.0

2/ RPA 408 0.7; and RPA 501 5.0

Problems and Objectives

Grain and cereal products are subject to damage, contamination, or deterioration in quality while in marketing channels. The estimated storage losses for the cereal grains, exclusive of insect damage, between 1951 and 1960 amounted to 92.5 million dollars annually. Much of this type of loss is caused by improper storage and growth of storage microorganisms. Other losses stem from injury and breakage in handling. To facilitate the marketing of grain, the industry is constantly seeking faster, automated methods of grading. Recent emphasis on consumer protection dictates that research on mycotoxins in grain used for food and feed be continued. Naturally occurring mycotoxins have been found in all the major cereal grains except oats and rye. Losses of basic grains and processed grain products in marketing channels due to stored-grain insect damage and contamination averaged 465.5 million dollars annually for the years 1951-1960, in spite of the millions of dollars expended for preventive and control measures. The projected production for 1980 is about double that of the 1950's. If losses in 1980 were reduced by one-third, a savings of about 300 million dollars would be realized not including reduced costs for improved control methods.

Major objectives of the research are to:

1. Develop equipment and methods to facilitate the grading of grain by automation or semiautomation.
2. Reduce storage, shipping and handling losses of grains.
3. Reduce mycotoxin production in grains and improve methods of detection and measuring mycotoxins.
4. Reduce losses caused by stored-grain insects through improved insect control procedures that minimize pesticide residues.

Progress - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

A. Quality Evaluation and Maintenance

1. Changes in wheat due to insecticides. There was no consistent or important change in the moisture content of Kansas-grown wheat treated with four inert dusts for insect protection during 36 months of storage. Treatment with the dusts reduced the grade from No. 1 or 2 to No. 3 or lower and test weight per bushel was lowered by as much as 3.4 to 4.1 pounds. However, dust treatment and reduction in test weight had no effect on the flour-yielding capacity, or on the chemical and physical

properties of the doughs or breadbaking properties. Fat acidity increased especially during the last 6 months of storage. Ash content and diastatic activity of flour made from the insecticide-treated wheats were unchanged. Other properties not affected by the dust treatment were: Sedimentation values, protein content, rheological values and initial bread-making properties. Minor decreases in loaf volume and crumb color occurred during the 36 months of storage. (FC-23)

2. Quality evaluation of fumigated wheat. In a 3-year cooperative study with Human Nutrition Research Division on fumigation of wheat with phosphine, methyl bromide, ethylene dichloride plus carbon tetrachloride, the stored wheat was evaluated every 3 months for various quality factors. The results indicate that the fumigated wheat was not significantly different from the controls for any quality factor studied. The only exceptions were a decrease in test weight for the phosphine-treated wheat at the 10th, 11th and 12th test periods and minor (non-significant) decreases in sedimentation values. (HN 1-22)

3. Quality changes due to insect-resistant treated bags. In an interdivision cooperative study to determine quality changes associated with storage of flour and cornmeal in insect-resistant treated bags the following results were obtained:

All-purpose flour - Fat acidity values increased significantly for all stored lots of flour. Some lots increased in fat acidity more than did others; the differences are believed to be related to the type of bag and amount of treatment used. There were no significant differences in bread-baking quality associated with the type of bag or insecticide treatment.

Cornmeal - There was no indication of significant changes in baking qualities of either regular or degermed cornmeal produced by the insecticide treatments. The only noticeable change was the increased fat acidity values of the regular cornmeal which varied somewhat due to the type of bag and level of insecticide treatment. Fat acidity of degermed cornmeal did not increase. (SP-60)

B. Prevention of Insect Infestation

1. Biology, ecology, physiology and nutrition. Certain insect progeny develop more readily in wheat that contains dockage. In a study of factors associated with this preference, wheat dockage (headhouse dust) contained 10 times more ash than clean wheat; 5 times as much fat; and 1/3 more carotene. Dust had 8% protein compared to 13% in clean wheat. Trace mineral analysis indicated that such dockage contained more Ca, Mg, Cu, Mn, Na, Fe, Zn, Ni, and Al than did clean wheat. (SP-49)

Larvae of the Angoumois grain moth did not develop in farina-bran pellets comprised of more than 30% bran or in germ-bran pellets with more than 10% bran. Newly hatched larvae failed to enter pellets containing 20% or more bran. Shortest larval-pupal periods were for moths reared in whole wheat kernels, averaging 36.1 days. The shortest larval-pupal periods of 37.3 days were in pellets of 70% farina-30% germ. The longest larval-pupal periods, averaging 145 days, occurred in 100% farina pellets. The number of larval instars increased with length of the larval period. The extremes consisted of one larva which had 12 instars in 178 days in farina while another larva molted 4 times in 20 days in whole wheat kernels. (SP-22 (A8404))

Ten insect species have developed in bulgur at 70% R.H. and 80°F. Development took longer than in wheat. Bulgur equilibrates at about 1% lower moisture content than wheat at the same R.H. The larger rice weevil develops faster and produces more progeny in bulgur. (SP-25 (A9353))

Surgical techniques have been developed for installing micropolyethylene tubes in the hindgut of yellow mealworm larvae for introducing and withdrawing tritiated water from the lumen to measure in vivo the rate of absorption by the rectal tissues. Results indicate rapid movement of water through rectal tissues into the hemolymph. Starved mealworm larvae held at different humidities gain weight by water absorption at R.H. above 90% and lose weight at about the same rate at lower humidities. Analysis of mealworm lipids as substrates for metabolic water production indicate lipids make up 14 to 18% of the live weight of the larvae and more than 50% are triglycerides. Major fatty acids are palmitic, oleic, and linoleic acids. (SP-27 (A9381))

The rice weevil, Sitophilus oryzae, will pick up and transmit Salmonella montevideo on the exoskeleton after being in infected wheat for 24 hours. Results to date are inconclusive concerning the presence of Salmonella in the digestive tract of the rice weevil. Preliminary and inconclusive results indicate that the progeny of Salmonella-infected rice weevils are not as easily infected internally as those from noninfected parent stock. A 1% solution of mercuric chloride was the most effective material tested to surface sterilize rice weevil and still retain Salmonella internally. One out of 200 samples of wheat from country elevators was positive for Salmonella serotype S. meuchen. Salmonella had survived in wheat under normal storage conditions for prolonged periods of time--perhaps years. Most of the molds in 6 samples of wheats and 1 sample of corn were Aspergillus flavus, A. glaucus, Neurospora, Penicillium and Mucor. Bacteria included the genera Aerobacter, Flavobacterium, Achromobacter, Bacillus, the coliform group, and other unidentified groups. Molds of the Aspergillus and Penicillium groups are normal in laboratory insects. The method for extracting aflatoxin has been revised and improved. (SP-28 (A9403))

Knowledge of the biology and ecology of the lesser mealworm is needed in a study of its transmission of acute leucosis to chickens. Mealworm pupae and adults can now be sexed by morphological features. Small squares of white paper clipped together are efficient oviposition sites. Eggs hatch only within a temperature range of 70° to 100°F, but the relative humidity can range from 7 to 95%. Preoviposition for virgin females is 9 days at 80°F. Starvation induces early pupation in late-instar larvae. (SP-35 (A9707))

The biology of the khapra beetle from India was studied with reference to diapause at various temperatures and population densities. Diapause is not a secondarily acquired adaptation of strains from colder countries. Notable tolerance to environmental stresses was noted. Proteinaceous globules in the fat body described as albuminoid granular or protein granules were numerous. Their chemical nature and function in insects is not understood, but complex cytochemical reactions and possible similarity in chemical composition to yolk spheres of insect eggs were shown. The globules are destroyed during pupation. Quantitative studies on fat, glycogen, and protein in normal and diapause larvae showed an enormous increase of these metabolites during diapause. Fat and glycogen were the chief sources of energy during diapause. With food available, body weight, fat, and glycogen content were constant during 3 months of diapause, indicating replenishment of the metabolites by intermittent feeding. Protein levels could not be established at beginning of diapause, but the significant decrease after 9 months without food during diapause showed considerable depletion of fat and glycogen. Cytological studies of the fat bodies of starved larvae corroborated this. Other studies indicated the use of fat and glycogen as chief sources of energy during larval-adult transformation. Adults from larvae induced with food to pupate after 2 months of diapause, laid more eggs than did nondiapausing individuals. (SP-39 (A7-MQ-3(a)))

Almond moths, corn sap beetles, and maize weevils were the 3 most prevalent insects found in representative samples of shelled corn stored for 8 months in a tobacco warehouse. (SP-52)

2. Biological and physical control. Of several biopreparations of the disease organism Bacillus thuringiensis tested against the Mediterranean flour moth, the "Anduze" strain from France was most effective. (SP-45 (E30-MQ-1(k)))

Histological study of female khapra beetle adults revealed that groups of ectodermal cells under the last abdominal sclerites near the ovipositor closely resemble glands that excrete attractive substances in Lepidoptera. Extracts of pheromones from virgin males and females of 3 ages were evaluated for attraction. If attraction is proportional to concentrations of pheromone, excretion of pheromone appears to increase with age of adults. In studies of cross-species attraction, Trogoderma granarium pheromone repelled Tenebrio molitor, Tribolium

castaneum, Dermestes maculatus, and Oryzaephilus surinamensis, but attracted Callosobruchus maculatus. Pheromone from T. molitor attracted T. granarium. (SP-41 (A10-MQ-11(k)))

About 700 varieties of wheat from the World Collection were screened in India for resistance to rice weevils. Fewer than 5 weevils per test sample emerged from 2.6% of the varieties. Of 745 varieties tested against lesser grain borers, 4.8% showed resistance to attack. Of varieties screened against both species, 6 were resistant to both. (SP-38 (A7-MQ-1(a)))

The oviposition rate of Sitophilus zeamais was significantly affected by differences in varieties of sorghum grown by natives of South Africa. (SP-20 (G9177))

Laboratory experiments showed that all ages of almond moth eggs were equally susceptible to parasitism by Trichogramma evanescens. (SP-52)

3. Improved insecticidal control. Gardona, 5% malathion in a granular carbon formulation, and a low-volume malathion emulsion treatment protected wheat in small bins from insect attack for 12 months. (SP-49)

Packaged food products in contact for 7 days with inside surfaces of railway freight cars treated with a 2½% solution of dichlorvos and malathion contained dichlorvos residues of less than 0.1 p.p.m. Fumigation of empty boxcars with 165 pellets of aluminum phosphide per 1,000 ft.³ killed 100% of test insects. Applications of malathion to newly harvested wheat by farmers using standard techniques showed wide discrepancies in amounts of insecticide actually applied--in some instances 1/50th the amount required for satisfactory insect control. Modification of application techniques will be studied. (SP-49)

Field tests on stacks of sacked delinted cotton indicated that 180 tablets of aluminum phosphide per 1,000-cubic-feet killed 100% of pink bollworm larvae exposed for 120 hours. Preliminary data from later small-scale tests indicate this dosage might be reduced considerably. (SP-50)

Amounts of malathion lethal to insects were deposited throughout corn masses in 14- and 26-foot columns of grain using thermal aerosols and forced air flow. Reversing air flow and introducing aerosols at top and bottom gave effective insect control at reduced dosage levels. Gas chromatography analysis in field-scale corn fumigations indicate that both carbon tetrachloride and ethylene dichloride applied by gravity rapidly penetrate warm corn masses. Ethylene dichloride penetrated more readily in warm corn than in either wheat or grain sorghum. (SP-50)

Two pints of 57% malathion emulsion applied to 1,000 bushels of grain sorghum as an undiluted ultra-low volume spray and as a high volume water-diluted spray gave excellent protection against insect damage. Malathion and diatomaceous earth mixed together protected the grain from insects better than either material applied separately at equivalent dosage rates. In recent field tests with 80:20 ($\text{CCl}_4:\text{CS}_2$) and 75:25 ($\text{CCl}_4:\text{EDC}$), gas chromatography analysis indicated that the components separate and present a fire hazard. These two fumigants should not be recommended for use on grain sorghum regardless of temperature, unless they are recirculated. (SP-51)

Dosage rates of 2 pounds of hydrogen cyanide, 2 pounds methyl bromide, and 165 aluminum phosphide pellets per 1,000 cubic feet gave complete kills of mature and immature stages of insects in bulgur. One fumigation with HCN resulted in a residue 294 p.p.m. (allowable tolerance 90 p.p.m.). Three fumigations with methyl bromide resulted in a 56 p.p.m. residue (allowable tolerance 125 p.p.m.). Three fumigations with PH_3 resulted in a .005 p.p.m. residue (allowable tolerance 0.1 p.p.m.). (SP-25 (A9353))

Data collected from samples of shelled corn stored in tobacco warehouses showed that malathion residues decreased at a faster rate in corn stored at shallow depths than in corn stored in upright bins. Malathion residues after 8 months averaged only 3.7 p.p.m. in corn 4 to 5 feet deep, and 1.7 p.p.m. on the surface. (SP-52)

Preliminary evaluations showed that relative humidity influenced the wide range of efficacy of several inert dusts against the granary weevil. (SP-45 (E30-MQ-1(k)))

4. Fate and effect of residues. It is assumed that malathion decomposition in wheat is based on enzymatic breakdown. Total lipids were determined on varieties sensitive and nonsensitive to sprouting. Total lipids decreased in both varieties until ripening and further during sprouting. This line of investigation is promising, as differences in lipid metabolism between the 2 varieties have been shown. (SP-43 (E8-AMS-6(a)))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Kernel Hardness. Research in Holland showed that the effect of moisture content and kernel size on the physical and biochemical properties of wheat do not parallel the effect of these factors on kernel hardness indices. At high moisture levels, the four indices of kernel hardness (resistance to cutting, resistance to compressing, Smetar value, and particle size index) indicated a decrease in kernel hardness, whereas pearling index and the Durograph Ae-value (grinding energy)

indicated the opposite. High moisture wheat gave a lower flour yield, finer granulation, lower ash content, lower protein content and lower maltose value than low moisture wheat. Kernel-size test results varied with test methods. (FC-21 (E19-MQ-1(a)))

2. Determining Proportions of Durum and Common Wheat in Semolina Products.

Research conducted in Spain showed that biochemical differences exist in Triticum durum and T. aestivum products. Generally T. aestivum contains a higher quantity of sitosteryl palmitate, digalactosyl glyceride, and/or lipoprotein. Assays based on these compounds may permit differentiation between T. durum and T. aestivum products. Also, higher quantities of a water soluble protein component were found in T. aestivum than in T. durum. (FC-22 (E25-AMS-7(a)))

3. Quality Evaluation of All-Purpose Flour. Tolerances for the alpha-amylase (falling number) content of all-purpose flour are now included in the USDA Agricultural Stabilization and Conservation Service specifications. This action was based on the work described in Marketing Research Report No. 804 entitled "Estimation and control of experimental error in the falling number test for wheat and flour." No changes in the factors studied other than falling number were found to be necessary for upgrading the quality of all-purpose flour. (FC-24)

4. Relation of Lipids to Grain Soundness and Quality. No significant differences were noted in the thin-layer chromatographic patterns of corn with high to normal moisture contents even though the fat acidity values decreased as the corn dried. Lipids extracted from germ-damaged wheat showed differences in the fatty acid fractions as compared to the lipids extracted from sound wheat. (FC-28)

5. Automatic Test Weight Device. Under contract research, an automatic test-weight device was developed which utilizes a commercial weight-sensing mechanism and indicator. The sample is placed in a hopper and flows by gravity into a test kettle mounted on a scale. The automatic grain leveling, or strike-off, operation duplicates the motions of the operator's hands in manipulating the stroker for the manual grain weighing operation. This action is accomplished by a motor driven mechanism. (FC-31(C))

6. Sound Grain Determination. X-ray stereomicroradiographs of grains gave good resolution. A system for automatic scanning of the microradiographs to record damaged kernels was developed and tested. An apparatus based on vapor equilibrium for the determination of moisture in grains was developed and tested. A prototype unit

consisting of two radiation detectors and a helium neon gas laser for evaluating the optical qualities of sound and damaged grains was developed. At 80% and 90% relative humidity and 70°F, corn and wheat showed different adsorption rates for sound grain and samples with varying amounts of damaged grain. (FC-32(C))

7. Optical Characteristics of Grains. Spectral reflectance curves of twelve different grains were made from 230 to 2450 millimicrons and mean reflectances, variances, standard deviations, and coefficients of variation were determined. All grains gave similar reflectance curves in the ultraviolet and infrared regions. In the visible region of the spectrum, the curves for oats and barley were similar to the curves for hard red spring and hard red winter wheat. Statistical analysis of the data has not been made. Determination of the profile characteristics of the same samples of the twelve different grains was started. (FC-33(C))

8. Isolating Germ of Grains. A modified wheat slicer cut dry wheat satisfactorily but did not show promise for concentrating the germ. By use of corrugated and smooth rolls, a moderately successful method was developed to concentrate most of the germ from wheat into a small fraction. A promising short simple bleaching and drying procedure was developed. (FC-34(C))

9. Automatic Moisture Meter. Kernel-to-kernel moisture variations within supposedly homogeneous samples did not exhibit normal distribution characteristics and indicated a large spread in moisture content. The results of differential thermal analysis and thermal gravimetric analysis indicate that, except for soybeans, accelerated moisture removal appears feasible. Effluent analysis of conventional and microwave heated grain showed that the amount of effluents, other than water, are so small that they would not interfere in moisture determinations. (FC-35(C))

10. Mechanical and Automated Sampling of Grain. High speed photographs of diverter-type samplers indicate that under certain conditions of grain flow the diverters will not accept all the grain presented to their entrances and the sample obtained may not be representative. A diverter-transporter has been constructed and will be used to study how diverter design influences performance.

The performance of three gravity-type secondary samplers (Boerner, Cargo and 4-way) and three powered units (Denver, Gamet and Gamet 7½) were studied but the data has not been analyzed statistically. In a study of barley samples drawn from 12 boxcars by mechanical samplers and a compartmented probe sampler, the samples drawn by the probe sampler were significantly higher in test weight than samples drawn by mechanical samplers. (FC-36)

11. Variation in Yeast and its Effect on the Experimental Baking Test. Exploratory tests indicate that variation might exist in commercial yeast purchased in the open market which will significantly affect baking tests. Experiments are being designed to determine the extent of this variation and whether we should culture our own yeast. (FC-116)

12. Grain Breakage Test. A Dillion Universal testing machine was found to be impractical for rapid testing. Cargill and Stein corn breakage testers were evaluated and the Stein unit was selected for further testing, using samples of corn, grain sorghum and soybeans. The results justify further use of the Stein corn breakage tester in developing a standard test.. (FC-113)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS AND NATURALLY OCCURRING TOXINS

1. Fungal Contamination and Metabolites in Grain. A rapid technique for screening corn samples for aflatoxin was developed. It is based on the assumption that if aflatoxin is present in a sample, it will normally be found in the mechanically separated cracked corn and foreign material portion. Several samples of corn known to contain aflatoxin had about 20 times more aflatoxin in the dockage portion (30 g.) than in the nondockage portion (8 lbs.). The effect of particle size of cornmeal on the concentrations of aflatoxins was studied. Results by the visual method showed that the coarse cornmeal (retained on U. S. screen No. 14) had three to four times the concentration of aflatoxin B₁ and G₁ as did the fine meal (retained on U. S. screen No. 80). A general decrease in aflatoxin concentration is apparent as particle size decreases. (FC-18)

2. Aflatoxin Production in Corn. When stored, nonsterile corn was incubated at temperatures of 55° to 105°F and at moisture contents of 14.5 and 19.5%, three groups of fungi predominated. Aspergillus glaucus competed best, growing in all 10 temperature-moisture combinations. Penicillium spp. preferred the higher moisture and competed best at temperatures of 55° and 65°F but one or more species grew substantially at 94° and 105°F. A. flavus grew little or none at 14.5% moisture. It grew at 65°F at 19.5% moisture but was favored by increasing temperatures.

Relatively high levels of aflatoxin were produced at the higher moisture and temperatures with maximum production at 94°F. Relative amounts of aflatoxins B and G were influenced by temperature, with more B₁ and less G₁ produced with increasing temperature. Although incubation at 80°F gave twice the amount of aflatoxin as incubation at 105°F, equal amounts of B₁ were produced and it was produced 2 weeks earlier at the higher temperature. Aflatoxin production declined after 12 weeks at 80° and 94°F and after 6 weeks at 105°F. (FC-19(A))

Mucor, Fusarium and Penicillium grew in high moisture corn stored in the presence of low oxygen and high carbon dioxide concentrations at 15.5° and 23°C. Fusarium moniliforme, although able to grow in corn at 0% oxygen, 60% carbon dioxide and 23°C, was unable to grow at 15.5°C.

Penicillium can grow at about 0°C, but cannot grow at oxygen levels of 0.5% or less and it is sensitive to high carbon dioxide levels.

Fusarium moniliforme and Penicillium grew better at 23% moisture than at 28%, probably because there was less competition with Mucor and aerobic bacteria at the lower moisture content. These findings account for failures of sealed storage of 20-24% moisture corn. (FC-82(A))

3. Control of Microorganisms in Stored Grain. An enzyme preparation consisting of amylase and protease is being tested for its ability to preserve high-moisture grain sorghum. Laboratory storage tests using this enzyme to date have failed to produce the controlled heating and fermentation that occurs in treated farm-stored grain. At moisture contents of about 25%, treated grain has remained high in palatability and nutritive value, with an anaerobic condition existing in the grain mass. (FC-124)

4. Refrigerated High Moisture Corn. Shelled corn with 26-27% moisture content was placed in three insulated bins in which the initial temperatures of 70°F were reduced at the rate of approximately 5°, 17° and 30°F per day, respectively, to a holding temperature of about 30°F. Rhizopus grew abundantly at temperatures of 50° to 60°F but failed to grow in the bottom of the fast-cooled bins. Mucor was more tolerant of low temperatures and grew in nearly all of the grain. Penicillium made moderate growth in the upper (warmer) layers and became quite abundant in the middle of the fast-cooled bin after about 2 months. Fat acidity values did not increase greatly except in the upper part of the slow-cooled bins. Germination decreased most in the upper portion of the slow-cooled bins. (TF2-057B)

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RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

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RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

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RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS AND NATURALLY OCCURRING TOXINS

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AREA 4a

RICE - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years F.Y. 1968			
	Research Problem Area			Total
	408	501	702	
Texas	1.0 ^{1/}	1.0	0.5	2.5
Total	1.0	1.0	0.5	2.5

Intramural program is supplemented by extramural support representing (a) 0.6 SMYs at State Agricultural Experiment Stations^{2/} and (b) P.L. 480 funds in four countries representing 66,879 U.S. dollars equivalent.

^{1/} Insect program; Beaumont

^{2/} RPA 408 0.1; RPA 501 0.5

Problems and Objectives

The farm value of rice produced in the United States in 1966 was \$405,369,000. To maintain the quality of rice, precise information is needed on metabolic changes, disease organisms and insect infestation. To insure the consumer a uniform and quality product, new and improved procedures for measuring quality in the inspection, grading and quality control operations must be developed. Losses of rice caused by stored-rice insects and the cost of their control for 1951-1960 were estimated to be about \$6.45 million annually. Based on a 40% increase in production of rice by 1980, an annual savings of \$2.75 million could be realized through improved control methods which would reduce losses by 33% and the cost of control by 25%.

Major objectives of the research are to develop methods and/or equipment for:

1. Reducing losses of rice during storage, transportation and milling through deterioration, disease and insect infestation.
2. Evaluating the quality of rough and milled rice rapidly and objectively.
3. Detecting and reducing mycotoxins in rice in market channels.
4. Detecting and reducing insect infestations and pesticide residues, and lowering the cost of preventing infestation.

Progress - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

1. Storage Changes in Milled Rice. Additional evidence confirms that the chemical composition of the outer layer of the kernel of milled rice greatly affects its cooking behavior. Cysteine disulphydrase activity in milled rice appears to be concentrated in the outer layer of the kernel. As storage time was increased, rice became darker, developed off-odors, had reduced tendency of cooked kernels to stick together and developed changes which are both desirable and undesirable. The nitrogen, sulfhydryl, and disulfide indices show trends associated with storage conditions and indicate significant changes in the protein material of the outer layer of the kernel. The population of microorganisms tends to decrease with time in storage. However, the proportion of Xanthomonas spp. and Aspergillus spp. increases with storage time.
(FC-73(E25-AMS-9(a)))

2. Biological and Physical Control of Insects. The biological significance of the constituents of rice that attract insects is under investigation. A component of polished rice attractive to the rice weevil appears to be an acidic substance of carboxylic nature that is soluble in water. Attempts to isolate the substance have not succeeded. (SP-42 (All-MQ-3))

Following elimination of the program at Fresno, California, and before the present laboratory at Beaumont, Texas, was established just prior to this reporting year, the research on the prevention and control of insects in rice was at a complete standstill. Time has been devoted to establishing a laboratory site, erecting and equipping a building, establishing adequate supplies of insect cultures, arranging for warehouse space, and making a survey to determine exactly what and where the problems are. Sufficient progress has been made to start a new research program with this year's crop. (SP-48)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Rice Sizing. Under a three-year contract, research was initiated to develop an automatic device that will separate brown and milled rice of the long, medium, and short grain varieties into whole, large broken, medium broken, and small broken kernels. No results are available. (FC-123(C))

2. Degree of Milling and Color of Rice. As a result of tests with the Rice Ratiospect, the Grain Division, Consumer and Marketing Service, purchased two additional instruments for critical evaluation. Preliminary results show that: (1) The instrument can be calibrated to give identical readings within an allowable tolerance; (2) compensation for error is necessary to obtain accurate measurements of degree of milling of rice containing contaminants such as heat-damaged, red rice, or chalky rice; and (3) the instrument indicates an apparent rapid deterioration (not yet defined) in rice after removal from cold storage that is not detectable by subjective measurements. (FC-91)

3. Hidden-Insect Detection in Grain. Techniques were developed for non-destructive detection of internal (hidden) insect infestation in grain with X-ray radiographs. A combination of proper exposure levels, film type, resulted in radiographs with sufficient detail that all stages of insect development from egg to mature larvae could be observed by microscopic examination of the film. Auxiliary chemical treatment of the infested grain has enhanced the X-ray density difference between infested and non-infested kernels but some false reactions continue to be a problem. Some progress has been made in developing a vacuum pick-up wheel for handling individual kernels of grain in an automatic X-ray scanning device. (FC-129)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS
AND NATURALLY OCCURRING TOXINS

1. Microbiological, Chemical and Physical Deterioration of Rough Rice. The ability of strains of the Aspergillus flavus group to compete with the common storage fungi, A. chevalieri and A. candidus, was studied under storage environments conducive to deterioration. A. flavus strains infected the rice most rapidly but were gradually succeeded by the other fungi. The competitive rank of the fungi depended in part upon the ratio of spore populations placed on the rice. Strains of A. flavus produced a wide range of pigments. Their capacity to produce pigments varied among strains within a species. Variability in pigment production is a probable cause of irregularity in the development of kernel discoloration in stored rice under conditions leading to microbiological deterioration. (FC-75)

2. Mycotoxins in Rice. In studies carried out in Japan the chick embryo test for toxicity was tested with six highly toxic fungi (Penicillium islandicum, P. expansum, P. utrinum, Aspergillus flavus, A. ochraceus and A. clavatus). Five compounds of known mycotoxin composition were also tested. The test was positive only with aflatoxin and culture broth in which strains of A. flavus were grown. Four hundred and sixteen strains of fungi were isolated from rice and cultured broths were tested for toxicity by oral administration to mice. None of the broths were toxic. Patulin was the toxic principle produced by P. expansum and A. clavatus. The latter also produced another toxic compound presumed to be dihydropatulin. (FC-74 (All-MQ-2))

Ethylene oxide and methyl bromide controlled internal infestations of fungi when applied at a rate of 32 mg/l. However, ethylene oxide reduced seed viability to zero at application rates as low as 8 mg/l. The internal flora of rice collected and studied in India consisted primarily of Aspergillus sydowi, A. flavus and A. niger. Examination of grain samples from 195 storage structures in Madras, Pondicherry, Kerala and Mahaiashtra States of India showed the following results: (1) Samples from structures of wood, paddy straw, and bamboo mat revealed little evidence of fungal deterioration; (2) fungal growth was observed in samples from brick and mortar structures. (FC-98 (A7-MQ-12))

In a pilot-scale study of the development of mycotoxins in stored undried rice in the United States aflatoxin developed in a highly irregular pattern when the rice was not aerated. Concentration of the contamination was usually low but mold counts were high and characterized by a preponderance of species other than A. flavus strains. Competition by fungi that do not produce aflatoxin greatly reduces toxin production and accumulation. (FC-78)

Publications - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

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- Barber, S., Benedito de Barber, C., Guardiola, J. L. y Alberola, J. 1967. Composicion quimica del arroz. IV. Distribucion de los azucares en el grano elaborado. Agroquimica y Tecnologia de Alimentos 7:346-353. (FC-73 (E25-AMS-9(a)))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

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- Schroeder, H. W. and Stermer, R. A. 1967. Market quality research of rice in Texas, 1966-67. Rice Jour. 70(7):99 and 104. (FC-75 and FC-91)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS
AND NATURALLY OCCURRING TOXINS

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AREA 4b

FEED AND SEED - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	: Scientist Man-Years F.Y. 1968		
	: Research Problem Area :		
	: 408	: 501	: Total
Maryland (Beltsville)	: 1.7	: 4.6	: 6.3
Texas	: 0.0	: 0.4	: 0.4
Total	: 1.7	: 5.0	: 6.7

Intramural program is supplemented by extramural support representing (a) 1.3 SMYs at State Agricultural Experiment Stations 1/, and (b) P.L. 480 funds in four countries representing 56,000 U. S. dollars equivalent.

1/ RPA 408 0.3; and RPA 501 1.0

Problems and Objectives

Production, processing and marketing of seeds constitutes a billion dollar industry in the United States. Expanding technology and agricultural production demands the testing of more samples and methods that will predict with greater accuracy the planting value of each seed lot. Present testing procedures are time-consuming and results frequently are not closely related to planting value of seed stocks. To consistently meet the needs of consumers, seed surpluses must be carried over from years of high production to years of low production. Seed stocks of 33 forage legumes and grasses held by dealers on June 30, 1966 amounted to 171.5 million pounds. It is known that some seed lots have a longer storage life than others but there is no method of predicting the storage life of a lot of seed. Seedborne diseases account for crop losses in the millions of dollars, yet methods for evaluating seed lots for diseases or disease organisms are impractical.

Major objectives of the research are to:

1. Develop improved techniques and equipment for measuring the germination, viability and vigor of commercial seed lots.
2. Develop improved procedures and equipment for measuring the purity and "sanitary condition" of commercial seed lots.
3. Develop methods and equipment for predicting the storage life of seeds.
4. Investigate the basic physiology and biochemistry of seeds as related to methodology and storability.
5. Develop methods of predicting the protein content of grains.

Progress - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

1. Maintaining the Viability of Seeds. Multiwall bags containing aluminum layers were impervious to atmospheric moisture. Paper bags offered little resistance to the passage of moisture. Studies on hardseededness with 24 cultivars of bean lead to recommendations that: (1) Plant breeders seek to eliminate varieties tending toward hardseededness and (2) seed distributors store varieties tending towards hardseededness under conditions which will maintain a moisture content lower than 10%. (FC-14 (E10-MQ-1(a)))

2. Changes Associated with Seed Deterioration. Amylase activity of germinating barley was less from seeds with a low storage potential than from seeds with a higher storage potential and amylase decreased as the seed deteriorated.

The salt tolerance of the storage fungi, Aspergillus flavus, A. niger, A. parasiticus, A. ochraceus and A. terreus, was compared to that of A. amstelodami, a known osmophilic species. The results showed that facultative ability to live on a high salt medium exists for species of Aspergillus not usually considered to be osmophilic. (FC-7 and FC-136 pending)

3. Predicting the Storability of Seeds. Germination percentages of 16 seed kinds were determined at intervals up to 12 months of storage under four different conditions: 7°C-45% R.H.; 20°C-75% R.H.; 30°C-75% R.H.; and open warehouse. These studies showed that the accelerated aging test was an effective means of predicting storage potential and provided useful data on the longevity of seeds under several different storage conditions. (FC-9(A))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

A. Germination Vigor and Dormancy

1. Environmental factors affecting germination. Extensive data were collected on the germination response of sorghum seed to a two-way, temperature gradient to determine efficient experimental designs and develop a method of statistically analyzing the data. Additional experiments are being conducted to resolve final problems in statistical analyses. A preliminary experiment involving Indian ricegrass seeds, indicated that temperature is probably not the principle factor controlling the laboratory germination of these seeds. (FC-5 in part)

2. Biochemical basis of seed germination. Studies with protein inhibitors indicated that two of the enzymes responsible for starch hydrolysis in pea seeds, alpha- and beta-amylase, are synthesized de novo and that a third enzyme, the R-enzyme, results from the activation of a preformed enzyme. Furthermore, a particulate fraction isolated from dry seeds yielded R-enzyme activity when subjected to protolytic hydrolysis. (FC-12 (A10-MQ-6(k))

3. Development of seed germinator. An automatic syphon spray humidifier was designed, constructed and tested to replace a heater type condensate evaporator. The performance of this humidifier was

found to be more satisfactory than the condensate evaporator. A complete set of plans, specifications and performance characteristics for an alternating temperature, thermistor controlled seed germinator were prepared and published as U. S. Department of Agriculture, ARS 51-17 (FC-92 in part)

4. Development of a method for measuring seed vigor. Respiratory measurements during the first two hours distinguished between vigorous and non-vigorous lots of corn and barley. The uptake of C¹⁴-labelled precursors into proteins and other organic constituents of germinating seeds was positively correlated with vigor in corn, barley, and wheat. Respiration and isotope incorporation data agreed in: (1) Indicating a rapid activation of both degradative and synthetic enzyme systems in seeds during the initial hours of germination, and (2) that measurements of activities based on these systems can provide valuable insights for seed quality evaluation. Respiratory measurements also detected tomato and pepper seeds pre-treated for rapid germination. A 2-vectorial analysis of seed vigor based on seedling growth over a range of environmental conditions was developed. (FC-2)

5. Environmental control of seed dormancy. Light exerts two effects on the germination of bluegrass seeds. Several brief, daily exposures promote germination, but when these exposures exceed one hour they are inhibitory. Greatest inhibition occurs in the far red, particularly in the 720-730 nm region. However, red light (shorter wavelengths) is inhibitory when applied continuously. A constant temperature of 20°C is best for showing the promotive and inhibitory light effects. These results are important for applied seed testing. (FC-5 in part)

6. Physiological maturity and dormancy of grass seeds. Seeds of Kentucky bluegrass harvested in the ripe stage were more dormant than seeds harvested in the early or late dough stage. In contrast, seeds of orchard grass and timothy harvested in the early dough stage were most dormant. Seeds of the 3 grasses showed benefit in preventing or reducing dormancy of drying at all stages of maturity. Drying decreased hard seeds of Trifolium repens and Vicia sativa harvested in the early stage of maturity and increased hard seeds of T. repens harvested ripe. Use of potassium nitrate or prechilling the seeds in the germination medium enhanced germination of timothy seeds. Prechilling increased germination of T. repens but had only a slight effect on the germination of V. sativa seeds after storage at low temperatures. (FC-15 (E10-MQ-3(a)))

7. Germination inhibitors in barley seeds. Three phenolic aldehydes previously isolated from barley were determined quantitatively using gas-liquid chromatography, paper chromatography, and UV techniques. In all cases, wild species (relatively more dormant) had higher aldehyde contents than cultivated species. When the aldehydes were applied to the same kind of seed from which they were extracted, they inhibited germination in some cases but not in other cases. More results are necessary to adequately establish the role of aldehydes as inhibitors of germination in barley. (FC-11 (A10-MQ-1(a)))

B. Methods and Equipment for Purity Determination

1. Method for determining purity of chaffy grass seeds. In searching for suitable solvents for flotation method for purity analyses two mixtures were found which caused only negligible damage to the germination of dalliagrass seed. The two mixtures are (1) hexane-carbon tetrachloride and (2) 2, 3, dimethyl butane-carbon tetrachloride. Both mixtures can be adjusted to the proper specific gravity for flotation purity analyses of many kinds of grass seed. Limited research with an air-comparison pycnometer showed it to be useful in determining density of the mixtures. (FC-92 in part)

2. Invisible marking of seeds for identification. Organic acid-base indicators and fluorescent substances were used as invisible markers. Marking materials are visualized when treated seeds are subjected to proper pH changes or to ultraviolet light. Markers were applied dry because previous research indicated that wet applications had adverse effects on seed germination. The markers did not adversely effect the function of fungicide applied to seed. When markers and seed kind were properly matched, no detrimental effects on seed appearance, viability, or storability were observed. A number of materials are of practical use, including bivalent and trivalent iron of which the anion is a weak acid and to which an antioxidant is added. Also, some fluorescent powders were found useful. (FC-13 (A10-MQ-5(a)))

3. X-rays and radiograms as aids in analyzing seeds. Further standardization of the X-ray photographic technique was accomplished. The following classification system was established for testing seeds for anatomical soundness by the X-ray method: Healthy (anatomically sound), mechanically damaged, empty, less developed (immature or under-developed), and insect infested. Impregnating seeds with barium chloride sometimes improves the contrast in X-ray radiograph. X-ray radiography is already becoming an established procedure for evaluating seeds in some seed laboratories and plant quarantine centers. Also, anatomical soundness is a fairly good indicator of viability in fresh seeds. Barium chloride impregnation is associated with seed viability. (FC-10 (A7-MQ-2(a)))

4. Development of seed purity testing equipment. A new semiautomatic sample divider with built-in sample weighing device was constructed and tested for accuracy and precision. A new seed blower was constructed and placed in semiproduction line hook-up with the semiautomatic sampler and the vibrator-separator, previously developed. An exhaust hood to protect the analyst from fine dusts and fumes was completed. (FC-8(C))

5. Methods of determining crop varieties by seed characteristics. Soybean varieties differ in their ability to produce viny seedlings when grown under suboptimal conditions in growth chambers. The viny characteristic is modified to some extent by differences in controlled environment. The source of the protein variant, found in soybean seed by electrophoretic analysis was traced to an introduction from Manchuria called "Mandarin." Efforts to develop a practical test for distinguishing between annual and perennial ryegrasses based on electrophoretic patterns were not successful. The variation in protein content of individual seeds is so great that negative readings do not necessarily indicate the complete absence of the subject protein. (FC-3)

C. Seed Pathology

1. Methods of detecting and identifying seedborne pathogenic fungi. Results of studies to measure the reflectance of visible light from the conidia of eighteen fungi showed the feasibility of characterizing the spore color of Aspergillus species. Satisfactory methods for the extraction and electrophoretic separation of water soluble mycelial proteins from seedborne Aspergillus species were developed. Electrophoretic analysis of A. flavus and A. parasiticus showed the two species to have 14 protein bands in common; an indication that they may be closely related. Isolates of different species of the genus Helminthosporium were obtained and identified for use in the development of selective culture media. Certain carbon sources may exert selective effects on the linear growth of some species of Helminthosporium and Fusarium on agar. (FC-4)

The perspex freezing method was modified with the elimination of blotters. Seeds are placed in depressions formed in the perspex plates, along with a small amount of water to which Terramycin is added. Seeds are allowed to imbibe at 20°C for 24 hours and are then killed by overnight exposure to -20°C. Subsequent incubation is done at 20°C, usually under near-ultraviolet light. (FC-16 (E19-AMS-11(a)))

D. Protein of Feed Grains

1. Method for predicting protein content of grain sorghums and other feed grains. A rapid colorimetric method was developed for predicting protein content in finely ground grain sorghum by substituting cupric carbonate for copper sulphate in the biuret reaction. The correlation of results between the Kjeldahl procedure and optical density readings for 77 samples of grain sorghum was $r = 0.95$. (FC-26)

Publications - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

Maintaining the Viability of Seeds

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RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

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Method for Predicting Protein Content of Grain Sorghums and Other Feed Grains

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AREA 5

LIVESTOCK AND MEAT - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	: Scientist Man-Years F.Y. 1968			
	: Research Problem Area			: Total
	: 412	: 501	: 707	:
Maryland (Beltsville)	: 1.0	: 5.5	: 1.0	: 7.5
Total	: 1.0	: 5.5	: 1.0	: 7.5

Intramural program is supplemented by extramural support representing (a) 2.1 SMYs at State Agricultural Experiment Stations ^{1/}, and (b) P.L. 480 funds in one country representing 13,200 U. S. dollars equivalent.

1/ RPA 412 1.1; and RPA 501 1.0

Problems and Objectives

The number of animals slaughtered under Federal inspection annually is over 26 million cattle, 14 million sheep and lambs, 70 million hogs and lesser numbers of calves, goats and horses. In addition, about 20 million pounds of meat food products are prepared and processed under Federal inspection. The Federal inspection and grading programs are confronted by many problems and are constantly being revised in accordance with advancing technology, in order to adequately evaluate the wholesomeness and quality of meat products.

Major objectives of the research are to develop and evaluate alternative ways for:

1. Identifying species of animals used in meat products.
2. Identifying carcasses of animals that meet death from sickness, heat exhaustion, accidents or other causes instead of being slaughtered by approved methods.
3. Determining appropriate lighting conditions for inspection.
4. Developing fast, simple, inexpensive methods for routine examination of meat for presence of pesticides and Salmonella contamination.
5. Developing improved procedures and evaluating equipment for grading and inspection to maintain quality and wholesomeness.

Progress - USDA and Cooperative Program

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

1. Development of Improved Methods for Maintaining Meat Quality in Market Channels. Research results show that beef carcasses and wholesale cuts arrive at retail delivery points with high surface microbial counts. Results show however that more stringent sanitation reduces initial bacterial counts on the lean surface of steaks and chops resulting in a 10-day shelf-life for prepackaged beef and pork and a 7-day shelf-life for lamb, if temperature is controlled properly. The shelf-life of prepackaged fresh meat can be extended by holding or displaying meat in refrigerated environments with minimum temperature fluctuations and by use of temperatures slightly above the freezing point of the meat. Light reduces shelf-life of prepackaged fresh meats. (MQ 2-75)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Relationship of Marbling to the Palatability of Beef. Evaluation of 60 carcasses showed: (a) Marbling level did not affect either shear force or panel tenderness; (b) no difference in pH due to maturity and marbling; (c) juiciness and flavor were influenced by marbling but not by maturity; (d) muscle bundle size increased markedly with maturity and could be estimated visually with some accuracy, and (e) kinkiness of fibers was greater in E maturity grades than in A or B maturity grades. (FC-57(C))

2. Objective Measurements of Beef Maturity. Investigation of chemical and physical changes in five muscles of Black Angus steers during maturation and aging was continued. Animals 6, 12, 18, 24, 30 and 36 months old have been evaluated thus far in this 7-year study.

A system for the simultaneous analyses of dual micro-samples of beef muscle extracts has been developed. This system is sensitive to the nanamole level of concentration for the twenty-seven ninhydrin positive substances found in beef muscles. Analyses for basic amino acids can be completed in 5½ hours, and analyses for acidic and neutral amino acids can be completed in 10½ hours by the use of this system. (FC-56)

3. Relationship of Age and Quality Factors to Palatability of Lamb. Data collected on the subjective and objective measures of quality and palatability characteristics of 120 lambs of unknown history and 234 lambs of known history are being analyzed. The relationships of maturity, feathering, flank streaking and flank firmness scores to lamb palatability were studied using leg roasts from 120 lambs of unknown history. Maturity score showed significant correlation with shear force (-.21), juiciness score (0.26), tenderness score (0.30), and average satisfaction score (0.27). Feathering score was significantly related only to shear force (-.18), while flank firmness was not significantly related to any palatability attribute. Quality factors, used singularly or in combination, explained less than 15% of the variation in leg palatability. (FC-64(A))

4. Comparison of Quality of Beef from Bulls and Steers. A study was initiated under a cooperative agreement with the University of Nebraska to determine whether meat from bulls and steers exhibiting the same grade characteristics differ chemically or histologically. Thus far, 9-month and 12-month-old animals from the first replicate have been slaughtered and this meat is being evaluated. (FC-114(A))

5. Post Mortem Changes in Quality and Functional Properties of Bovine Muscle Proteins. A study was initiated under a cooperative agreement with the University of Oklahoma to isolate and identify proteins at intervals before and during aging of beef to determine what changes are occurring and how such changes can be modified. The transformation of G-actin to F-actin was found to be affected by the ionic strength of KCl, temperature, pH and protein concentration of the system. (FC-102(A))

RPA 707 - PREVENT TRANSMISSION OF ANIMAL DISEASES
AND PARASITES TO PEOPLE

1. Identification of Meat Slaughtered by Approved Methods. Hemoglobin-myoglobin ratios of bovine, ovine and porcine muscles are being determined to ascertain whether such ratios can be used as an indication that animals had been slaughtered by improper procedures. Bacterial counts and pH determinations of the muscles are also being made. Thus far, the study has been limited to obtaining normal values for properly slaughtered animals. (FC-58(C))

2. Identifying Species of Origin of Heated Ground Meat. Results indicate that sera of rabbits immunized with coctoglobulins (Ac-avian, Bc-bovine, Ec-equine, Oc-ovine and Pc-porcine) may contain species-specific antibody, interspecies cross-reacting antibody or a mixture of the two. Absorption of an antiserum containing a mixture of such antibodies, with specific coctoglobulins has been used to identify the presence of bovine and ovine meat in sausage. It appears that preparation of antisera with species-specific antibodies when avian, equine and porcine coctoglobulins are used as antigens, will not pose any great problems. (FC-100(A))

3. Methods for Cutting and Thawing Frozen Meat. An experimental study of methods for rapidly thawing frozen meat samples was conducted under contract by the Battelle Memorial Institute using available dielectric and microwave heating equipment in five energy ranges: 6-8, 13-15; 27; 915; and 2450 MHZ. Adequate thawing of unprotected meat samples, with minimum change in meat quality, was accomplished using a 15-minute exposure in batch feed, dielectric heating equipment operating at 13-15 MHZ. Thawing at 915 MHZ, without burning the samples, could only be accomplished when the meat was protected by a polystyrene tray fitted with a lid which was supported above but did not touch the upper meat surface. Thawing without burning could not be accomplished by any means at 2450 MHZ. The results at 27 MHZ were generally acceptable, although this frequency would be difficult to scale up because of limitations on electrode size. The results at 6-8 MHZ were also satisfactory. (FC-94(C))

4. Identification of Vegetable Proteins Added to Meat Products.

Investigation of chemical procedures for the detection of vegetable soy protein in meat products has been conducted by: (1) Pentose and pentosan determination; (2) electrophoretic separation of protein fractions with polycellulose acetate strips; and (3) dye-binding capacity of proteins present in meat extracts. The dye-binding capacity was the best. Detection of added soy protein in the form of soy flour, soy protein, concentrate and isolated soy protein was possible at the 1% level in baloney and frankfurter products. The level of detection in luncheon meats, processed ham products, was about 2%. Dye-binding capacity, however, is not specific for vegetable protein. A means of positively identifying the protein as a vegetable protein is necessary. (FC-118)

Publications - USDA and Cooperative Program

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

- Hoke, K. E. 1967. Problems associated with the transportation of fresh meat. Proc. 20th Annual Reciprocal Meat Conference, Lincoln, Nebraska, June. (FC-59 (E8-AMS-5(a)))
- Hoke, K. E. 1968. Can off-condition of dressed beef be prevented? What causes off-condition and how can it be prevented? What bacterial tests have been conducted? Proc. 22nd Annual International Conference on Handling Perishable Agricultural Commodities, Lafayette, Indiana, March 18-21. (FC-59 (E8-AMS-5(a)))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

- Hornstein, I., Crowe, P. F. and Hiner, R. 1968. Composition of lipids in some beef muscle. J. of Food Sci. 32:650-655. (FC-57(C))
- Hornstein, I., Crowe, P., and Ruck, J. B. 1967. The effect of silicic acid and alkali concentration on the saponification of lipids. J. Gas Chromatog. 27:485-487. (FC-57(C))
- Hornstein, I., Crowe, P. F. and Ruck, J. B. 1967. Determination of peak areas in lipid analysis. J. Gas Chromatog. 319-322. (FC-57(C))
- Ling-Mu Chen and Guenther, J. J. 1968. Isolation and purification of bovine G-actin and the formation of its polymer. Abstract. Southern Section, Amer. Soc. of Animal Sci. (FC-102(A))
- Rickansrud, D. A. and Guenther, J. J. 1968. Electrophoretic characteristics of protein fractions from bovine muscles. Abstract. Amer. Soc. of Animal Sci. (FC-102(A))
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- Smith, G. C., Carpenter, Z. L., and King, G. T. 1968. Ovine muscle collagen content and solubility. Proc. Amer. Soc. Animal Sci., Stillwater, Oklahoma, July Abstract. (FC-64(A))
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- Smith, G. C., Spaeth, C. W., Carpenter, Z. L., King, G. T., and Hoke, K. E. 1968. The effects of freezing, frozen storage conditions and degree of doneness on lamb palatability characteristics. J. Food Sci. 33:19-24. (FC-64(A))

RPA 707 - PREVENT TRANSMISSION OF ANIMAL DISEASES
AND PARASITES TO PEOPLE

- Hoke, K. E. 1967. Equipment to ready imported frozen boneless meat for inspection--what's suitable. National Provisioner 92-96, September 16. (FC-94(C))

AREA 6

OILSEEDS AND PEANUTS - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years F.Y. 1968			
	Research Problem Area			Total
	408	501	702	
Georgia	0.6	1.4	1.0	3.0
Georgia (Insects)	2.6			2.6
North Carolina	1.0	2.0	0.5	3.5
Texas	0.2	0.3	0.6	1.1
Total	4.4	3.7	2.1	10.2

Intramural program is supplemented by extramural support representing (a) 0.2 SMYs at State Agricultural Experiment Stations ^{1/}, and (b) P.L. 480 funds in two countries representing 24,682 U.S. dollars equivalent.

1/ RPA 408 0.2

Problems and Objectives

Oilseeds and peanuts are highly subject to deterioration and quality loss through fungus and insect attack, development of mycotoxins, metabolic changes and instability of oil constituents. Peanut flavor is subject to deterioration while in the market place due to improper aeration, drying, handling and storing. Losses caused by insects and cost of control measures averaged \$12,868,000 annually during the period 1951-1960. Based on a 2-fold increase in production by 1980, improved and less-costly insect control methods could produce savings in excess of \$8 million.

Major objectives are to:

1. Reduce storage losses caused by fungi and insects.
2. Determine the conditions which favor mycotoxin production.
3. Develop new and improved methods and equipment for inspection and grading.
4. Determine factors responsible for food-quality losses.
5. Develop insect control procedures that are more effective and leave less residues.

Progress - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

A. Quality Maintenance in Handling, Drying and Storage

1. Effects of handling, conditioning and storage on market quality of peanuts. In a windrow-drying experiment the growth of Aspergillus flavus fungi and the field molds were favored more by 70% relative humidity than either 85% or 100% R.H. which does not agree with findings of other researchers. Peanuts harvested and dried immediately after digging show significantly less contamination than those harvested after 7 days in the windrow. Contamination increases with the length of time that the peanuts are held in the windrow. Data indicate that Spanish peanuts may be more susceptible to mold in the windrow than Runners and Runners more so than Florigiant. Mold assays of the Florigiants showed that they were heavily infected with A. flavus spores which suggests that they may contain an inhibitor that retards the production of aflatoxin. Peanuts exposed directly to sunlight in the windrow have lower acidity than ground, shaded or inverted peanuts. Peanuts build up fat acidity faster at 85% and 100% relative humidity than at 70%. (FC-83)

2. Drying of peanuts.

(a) Drying with refrigerated air. Neither low temperature nor airflow affected the population of Aspergillus spp. or "field" fungi significantly. On the other hand, Penicillium spp. population increased significantly. Thus, low-temperature drying appears to be inferior to heated air drying for reducing the population of fungi. Peanuts dried with low-temperature air had an average fatty acid content of 2.0% as compared to 0.5% for peanuts dried with heated air. The average fatty acid content of peanuts from the top of the bin was over three times that at the bottom. At the middle it was over two times as high as at the bottom. Results of flavor and roasting tests point to a direct relationship between drying temperature and roasted color. The higher the drying temperature of peanuts, the darker the roasted color when processed. A flavor panel indicated a preference for ambient-dried peanuts over low-temperature treated peanuts. Drying peanuts with low-temperature air lowered the skin slippage of the Spanish, but increased that of the Runner and Virginia. Color of peanut butter made from peanuts removed from the top of the bin was darker than the butter made from peanuts at the middle of the bin and the latter was darker than butter made from peanuts at the bottom of the bin. (FC-107(A))

(b) Effects of heated air drying. No aflatoxin was found in any of the samples dried with heated air on a wire mesh belt. There was a significant decrease in the number of colonies of Penicillia and field fungi after drying but no significant change was found in the number of colonies of A. flavus. Previous work has shown that peanut skin slippage varies considerably from year to year. This study indicates that not only the treatment and variety, but also maturity may affect skin slippage. Color measurements indicates that the Spanish peanut butter is significantly lighter than either the Runner or the Virginia peanut butter. The lighter color of the butter made from Spanish peanuts correlates with the preferred flavor and higher level of maturity of either the Virginia or Runner peanuts. (FC-83)

3. Effects of storage temperature on quality of vegetable salad oils. Soybean salad oils (without synthetic antioxidants) stored at 90°F and higher deteriorated noticeably in flavor when compared with the same oils stored at 0°F. Pasteurization at 140°F for 4 days appeared to dissipate these "off flavors." The elevated temperatures probably removed objectionable low-boiling compounds formed during storage without access to air.

Cottonseed salad oils (without synthetic antioxidants) stored for 2 years at 55° to 110°F differed very little in flavor from oils stored at 0°F. When stored oils were pasteurized for 4 days at 140°F the difference in flavor was even less pronounced. (FC-76)

B. Prevention of Insect Infestation

1. Biology, ecology, physiology and nutrition. Approximately 20 species of stored-product insects have been collected in and around peanut shelling plants during the shelling season. Almond moths, red flour beetles, and merchant grain beetles were the most prevalent species; and the first two accounted for 90% of the total catch in suction-type light traps.

Experiments conducted under field conditions in a shelling plant showed that peanuts were very attractive to stored-product insects. One-pint samples of peanuts left in a shelling plant for 1-7 days showed that 40% of the samples were infested within the first 24 hours. An average of 75% of the samples were infested after 48 hours. Shelled peanuts are often held at the plant from 1 to 3 days awaiting grade certificate and shipping. This could be a major source of infestation. (SP-53)

2. Biological and physical control. A mixture averaging 48% carbon dioxide, 10% oxygen and 42% nitrogen produced 87% mortality of saw-toothed grain beetle adults exposed 1 day at 90°F. At low temperatures, high concentrations of carbon dioxide were more effective than were high concentrations of nitrogen.

A 1-day exposure at 80°F to a mixture of 40% carbon dioxide, 12% oxygen, and 48% nitrogen killed all 1-day-old adult Indian-meal moths. This mixture produced 100% mortality of lesser grain borer adults and 95% mortality of the rusty grain beetle adults in 3 days.

A 7-day exposure of adults of the confused flour beetle, red flour beetle, and a malathion-resistant strain of red flour beetle to a mixture consisting of 39% carbon dioxide, 13% oxygen, and 48% nitrogen produced mortalities of 1, 25 and 37%, respectively.

Three silos, each containing from 20,000 to 30,000 bushels of corn, wheat, or oats, were purged with carbon dioxide. A concentration of more than 35% carbon dioxide and less than 14% oxygen was attained and maintained with good distribution for periods from 24 to 96 hours after this concentration was reached. This concentration was found to be lethal to many stored-product insects in laboratory tests. Five-gallon cans of wheat treated with carbon dioxide had a concentration of more than 35% of this gas 4 weeks after application. (SP-56)

3. Improved insecticidal control. Bayer 77488 was the most outstanding of six compounds evaluated as a protectant for farmers' stock peanuts in small-bin tests.

Observations in farmers' stock peanut warehouses revealed that current recommendations for use of malathion as a protective treatment were still adequate for effective insect control when the insecticide was properly applied. The almond moth continued to be the most prevalent insect, but only two warehouses had populations high enough to damage the surface peanuts. (SP-53)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Stinkbug Damage of Soybeans

(a) Effect of stinkbug damage on soybean quality. Results are inconclusive because the undamaged soybeans had a higher moisture content than the damaged beans at time of harvest. Fat acidity was higher in the undamaged than in the damaged soybeans and increased more rapidly during storage. Soybeans grown in cages were found not to be entirely free of stinkbug damage. (FC-30(C))

(b) Estimating stinkbug damage in soybeans. A decrease in the density of soybeans due to stinkbug puncture is the basis for development of a practical method to determine the extent of damage. The time required for a soybean to drop between two points in a vertical tube filled with water is dependent on the density of the bean. An instrument was developed to make the measurement rapidly. The mean time of fall of a large number of beans from a sample gives a measure of the extent of stinkbug damage. (FC-29)

2. Methods and Equipment for Measuring Quality of Peanuts

(a) Measurements of market quality. Development work was undertaken on a conductometric method for measuring fat acidity in peanuts. It is based on the conductivity measurements of the hexylamine salts of the fatty acids in butanol. The method has an accuracy of .01%, is rapid, economical and simple. Over 2,000 samples of peanuts have been analyzed with excellent results. A method of measuring maturity by optical density measurements of the cold pressed oil from raw peanuts at wavelengths of 380, 450 and 520m μ in comparison with distilled water, was investigated. After correcting for haze, an optical density reading of greater than 0.1 is an indication of immaturity. Approximately 300 assays were made with this method and results appeared to agree with organoleptic evaluations of peanut maturity.

An equation was developed for converting refractive indices of vegetable oil to iodine numbers. The measurement of the refractive index of an oil is relatively simple and rapid, whereas an iodine determination is an involved chemical procedure. Preliminary work indicates that the moisture distribution in the peanut kernel is related to the degree of denaturization of the endosperm. Evaluation testing with the tristimulus colorimeter has shown that an acceptable peanut butter can be obtained from peanuts cured at excessive temperatures if the proper roasting procedure is used. Color of the peanut butter is related to flavor and is an indication of the degree of roast. (FC-84)

(b) Sampling. Results of a study to relate sample size to the accuracy of estimating the average concentration of aflatoxin in populations of shelled peanuts indicates that sampling accuracy increases as:

(1) The sample size increases for a given average level of aflatoxin and percent of contaminated peanuts in the population; (2) the percent of contaminated peanuts increases for a given average level of aflatoxin and sample size; and (3) the average level of aflatoxin decreases for a given percent of contaminated peanuts and sample size. Based upon the results of this study recommendations have been made to the peanut industry concerning the size of samples and sampling procedure required for aflatoxin determinations.

An experimental sampling device was designed and constructed to automatically take a representative sample from a flowing stream of shelled peanuts. Tests of it are in progress. Studies were made of the accuracy of the pneumatic sampler and the spout-type sampler for farmers' stock peanuts in the Virginia-North Carolina area. The data indicate that samples drawn with the pneumatic sampler are more nearly representative of the lot in regard to foreign material than samples drawn with the spout-type sampler. (FC-48)

3. Biochemical Changes Associated with Market Quality of Peanuts.

The volatile constituents of NC-2 variety raw peanuts consist of pentane, acetaldehyde, octane, acetone, methyl formate, 2-butanone, methanol, ethanol, pentanal, and hexanal. Only quantitative differences were found in the volatile profile of nine additional varieties from two locations.

A slow rate of curing (stack pole) reduces the carotenoids in the extracted peanut oil. There is evidence that this reduction occurs through a lipoxidase-linoleic acid-carotenoid system. The level of lipoxidase activity increases linearly with maturity from the fifth week through the thirteenth from pegging.

Use of photosynthetically ^{14}C labelled peanuts has shown that anabolic activity in immature peanuts continues during curing until the moisture content reaches approximately 45% where there is a continuance only of the catabolic activities. In mature peanuts the moisture content had already fallen below 45% at harvest and no anabolic activity was observed during the curing process. (FC-47)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS AND NATURALLY OCCURRING TOXINS

1. Development and Control of Mycotoxins in Spanish Peanut.

Aspergillus flavus and closely related species isolated from peanuts vary in aflatoxin-producing ability on peanut over a range from zero to >500,000 ppb. Subcultures (single conidia isolates) from a single mass isolate may vary greatly in toxigenicity. It follows that the dominance of toxin-producing strains in a particular lot or field of peanuts can greatly affect the amount of toxin-contamination that may occur. Non-toxin-producing fungi and bacteria are capable of preventing or greatly decreasing aflatoxin production. The degree of prevention depends on time of infestation, population ratio, and environmental factors such as moisture content and temperature.

Strains of the fungus, Macrophomina phaseoli, isolated from peanut, produce an apparently toxic metabolite in significant quantities. The compound was toxic to chick embryo in preliminary tests. Like aflatoxin B, it has a blue fluorescence under long wave-ultraviolet light when viewed on a thin-layer-chromatographic plate. The compound has the same R_f as aflatoxin B₂ under the above conditions and can easily be confused with it. (FC-78)

2. Factors Involved in the Production of Aflatoxin by Aspergillus flavus.

Major phospholipids present in a toxigenic and a non-toxigenic strain of A. flavus were: phosphatidyl inositol, phosphatidyl serine, sphingomyelin, lysophosphatidyl choline, phosphatidyl choline, phosphatidyl ethanolamine, phosphatidic acid and polyglycerophosphatides. Lysophosphatidyl ethanolamine could not be detected in the non-toxigenic strain. Qualitative identification studies for neutral lipids indicated the presence of mono-, di-, and triglycerides, free fatty acids, two ergosterol spots, and three unidentified sterol spots. Using cell-free systems in which ^{14}C -labelled acetate, leucine, and mevalonate were fed to the different cell fractions, it was found that the mitochondrial fraction was able to incorporate these labelled substrates into aflatoxins. (FC-54 (A7-MQ-7(a)))

3. Biochemical Characterization of Fungal Metabolites. The growth stimulant properties of a metabolite isolated from Penicillium urticae and P. cytopium was evaluated by the Avena coleoptile procedure. Addition of 3-indoleacetate to the medium increased the length of coleoptile tissue by 43% over the control; by substituting 1.0, 0.1 and 0.001 mg of the aqueous chloroform extract of the metabolite for the 3-indoleacetate a similar increase in coleoptile length resulted. Methylation with diazomethane followed by column chromatography on deactivated aluminum oxide failed to resolve the crude chloroform extract into a single component. Oxidation of the partially purified extract revealed the presence of two components, one is apparently the oxidation product of the other. Both compounds exhibit growth stimulating properties. Preliminary structural analysis indicates the metabolite possesses a nitrile moiety. (FC-133)

4. Mechanisms of Fungal Deterioration Affecting Market Quality of Peanuts. A gas-liquid chromatograph has been set up and solutions of amino acids, organic acids, and other biochemicals are being standardized for quantitative analysis in planned experiments involving the interactions of storage fungi and peanut kernels. Other techniques, such as thin-layer chromatography and column chromatography are being evaluated for use in this study. (FC-120)

5. Rapid Detection of Molds and/or Fungal Metabolites

(a) Aflatoxin detection. A rapid detection method for aflatoxin based on millicolumn chromatography and consisting of extracting a sample of raw peanuts with a mixture of chloroform and methanol, filtering, placing a millicolumn in the filtered extract and developing the millicolumn was developed. The millicolumn is viewed under a source of long-wave ultraviolet radiation. The columns are prepared by filling a length of 4 mm glass tubing with silica gel to a depth of about 5 cm. Glass fiber plugs are inserted in the tube to hold the silica gel in place. The method is inexpensive, simple and rapid, requiring only about 15 minutes for an assay. (FC-85)

(b) Mold identification. Studies were initiated on the identification of Aspergilli and Penicilli by using a pyrolysis technique in conjunction with a gas-liquid chromatograph. This method "fingerprints" the fungi. Tetramethylammonium hydroxide digests of fungal spores have also been made for these fingerprinting studies. Techniques for the chromatography of both the pyrolytic and digestion products have been worked out. (FC-85)

(c) Relationship of visible molds to aflatoxin in peanuts. Visible A. flavus growth has received further study. Data based on over 2,000 lots of farmers' stock peanuts marketed in Georgia indicate that 95% of the aflatoxin in all of the lots was concentrated in less than 5% of the lots. These lots in which the aflatoxin was concentrated contained kernels with mold that appeared to be A. flavus under 25X magnification. Inspectors can be trained to detect peanut kernels with mold having visual characteristics of A. flavus and can detect a large percentage of the lots of farmers' peanuts which contain high concentrations of aflatoxin. The Peanut Administrative Committee, representing the peanut industry, has made inspection of farmers' stock peanuts for visible A. flavus mandatory throughout the United States during the 1968 marketing season. Peanuts containing kernels with mold which appears to be A. flavus will be diverted to separate storage when purchased from the farmer. A study of 2,567 samples from shipments of shelled peanuts indicated that examination for A. flavus growth is not a dependable method to detect shipments of shelled peanuts which contain aflatoxin. The cause for this difference between farmers' stock peanuts and shelled peanuts is being studied. (FC-49)

6. Commercial Drying, Handling and Storage of Peanuts. Farmers' stock peanuts from 25 locations in North Carolina, 18 in Alabama and 28 in Georgia showed wide differences in the distribution of visible A. flavus. A study of the harvesting, drying and handling procedures and local weather conditions did not explain these differences. A. flavus grew from kernels taken from 94% of the peanut samples collected from 49 farms throughout the peanut growing area of North Carolina at time of combining. These data indicate that A. flavus is prevalent throughout the peanut-growing area of North Carolina and will infect farmers' stock peanuts if conditions are favorable for its growth.

In a study of a mathematical model to approximate the observed drying rate of peanuts in thin layers, the diffusion equation in spherical, cylindrical, and rectangular coordinates was investigated. Using the method of least squares, the diffusion equation in spherical coordinates gave the best fit. (FC-46)

Publications - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

Quality Maintenance in Handling, Drying and Storage

Baughman, L. A., McConnell, D. G., Moser, Helen A. and Davis, C. D. 1967. An evaluation of the oxidative flavor stability of stored soybean oils. J. Amer. Oil Chem. Soc. 44:663-666. (FC-76)

- Burns, E. E., Clark, L. E., Harrison, A. L., Kunze, O. R., Langley, B. O., Persons, N. K., Jr., Pettit, R. E., Schroeder, H. W., Sorenson, J. W., Jr., and Taber, Ruth A. 1967. Effects of several drying procedures on quality of Spanish peanuts. Texas Agricultural Experiment Station MP-857. (FC-78)
- Dickens, J. W. and Khalsa, J. S. 1967. Windrow orientation and harvesting damage to peanuts. *Oleagineux*. 22:741-746. (FC-46)

Prevention of Insect Infestation

- Harein, Phillip K. and Press, Arthur F., Jr. 1968. Mortality of stored-peanut insects exposed to mixtures of atmospheric gases at various temperatures. *J. Stored Prod. Res.* 4(1):77-82. (SP-56)
- Press, Arthur F., Jr. and Harein, Phillip K. 1967. Mortality of Tribolium castaneum (Herbst) (Coleoptera, Tenebrionidae) in simulated peanut storages purged with carbon dioxide and nitrogen. *J. Stored Prod. Res.* 3(2):91-96. (SP-56)
- Press, Arthur, F., Jr. and Harein, Phillip K. 1967. Atmospheric gas alteration and insect control in peanuts stored at various temperatures in hermetically sealed containers. *J. Econ. Entomol.* 60(4):1043-1046. (SP-56)
- Speirs, Roy D., Redlinger, L. M., and Boles, H. P. 1967. Malathion resistance in the red flour beetle. *J. Econ. Entomol.* 60(5):1373-1374. (SP-53 and SP-61)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

- Pattee, H. E. and Swaisgood, H. E. 1968. Peanut alcohol dehydrogenase: I. Isolation and purification. *J. of Food Science* 33:250-253. (FC-47)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS AND NATURALLY OCCURRING TOXINS

- Borut, S. Y. and Joffe, A. Z. 1966. Aspergillus flavus Link and other fungi associated with stored groundnut kernels in Israel. *Israel J. Bot.* 15:112-120. (FC-46)

AREA 7

COTTON AND COTTONSEED - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	: Scientist Man-Years F.Y. 1968			
	: Research Problem Area :			
	: 408	: 501	: 702	: Total
South Carolina (Clemson)	: 4.0	: 4.0	:	: 8.0
Washington, D. C.	: 1.0	: 1.0	: 1.0	: 3.0
Total	: 5.0	: 5.0	: 1.0	: 11.0

Intramural program is supplemented by extramural support representing (a) 0.8 SMYs at State Agricultural Experiment Stations ^{1/}, and (b) P.L. 480 funds in one country representing 5,741 U. S. dollars equivalent.

1/ RPA 408 0.8

Problems and Objectives

The substitution of instruments for measuring cotton quality factors offers a promising opportunity to better define the quality of the American cotton crop. This would represent a \$17,500,000 quality improvement per year based on a 10,000,000 bale crop. An additional savings of \$2,000,000 would result from lower ginning cost due to less handling and equipment requirements.

Cottonseed is subject to deterioration in quality and loss in value through fungus growth and contamination, normal metabolic changes and instability of its oil constituents when exposed to the atmosphere. Research which will reduce these losses (either the health hazards or dollar value) would be in the interest of the industry and the public.

Major objectives of the research are to:

1. Evaluate instruments and techniques for measuring cotton fiber quality characteristics.
2. Develop improved spinning performance tests and testing equipment.
3. Provide information for the improvement of the cotton and cottonseed grading systems.
4. Determine the effect of various production, harvesting, storage and ginning practices on lint cotton quality and grade classification as a basis for improving the marketing of cotton.
5. Study effect of ambient conditions on the development of molds and aflatoxins in cottonseed.

Progress - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

1. Cottonseed Oil Quality. Treating refined cottonseed oils with strong sulfuric acid and filter-aid removes much of the color pigments. However, when this treatment was used with oils that are refined after accelerated storage (high temperature) of the crude oil, pigment removal was less complete. Probably, some of the gossypol pigment product was not adsorbed by filter-aid, and hence, was not hydrolyzed by the acid. (FC-76)

2. Effect of Various Production, Harvesting and Ginning Practices on Cotton Quality and Spinning Performance.

(a) 1966 Color and Trash Level Study. Test results from four areas of the cotton belt: (1) Southeast - picker harvest; (2) South Central - picker harvest; (3) Southwest - stripper harvest; and (4) West - picker harvest, showed similar trends in that (1) trash content affected classification results much more than did color of the fiber, (2) change in color of the fiber was very small due to exposure, and (3) late harvest resulted in deterioration of fiber and spinning quality. However, color was not related to these factors. (FC-65)

(b) Moisture Content of Cotton for Optimum Gin House Operation. A monoflow system was designed by ginning engineers to control moisture during ginning. Preliminary test results showed that cottons ginned with this new system produced less waste and better yarn quality than did cottons ginned with a conventional system. (FC-65)

(c) 1967 Chemical Additive Study. This study was designed to extend last year's work by including higher rates of applications of X-78 during ginning. Small-scale spinning and dyeing results showed essentially no differences due to the additive. (FC-65)

(d) Tandem Vs. Split Lint Cleaning Study. Lint cleaners had only small effects on spinning performance and yarn properties for early harvest cottons. For late harvest cottons, two lint cleaners in split design gave slightly better results than did two lint cleaners in tandem. However, the use of one lint cleaner gave as good or better results than two lint cleaners operated in tandem or split design. (FC-65)

3. Surface Contamination of Cotton Fibers. (a) A rapid, accurate method for both qualitative and quantitative detection of arsenic residues on cotton was developed, and (b) a reliable method, sensitive at the level of application recommended by the manufacturer, was developed to detect the presence and amount of a cationic conditioner left on raw cotton. (FC-67)

4. Measurement of Frictional Properties of Cotton Fibers During Processing. A new Spin-Draft Tester has been developed which can measure drafting force and drafting-force variability under normal drafting operations. Good progress is being made in determining drafting-force optimums for cotton spinning. Preliminary tests involving the Spin-Draft Tester and large-scale spinning indicate that 40s yarn spun from 1.00 hank roving has optimum spinning efficiency at a drafting tenacity of approximately 1.2 grams per tex. (FC-66)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Instrument Evaluation. A new production-line testing system is being set up and evaluated for grading cotton using the following instruments: (a) Outlook Cotton Color-Trash Meter. This instrument is a combination of the Outlook Trash Meter and a colorimeter and is designed to measure trash and also color without the effects of trash. (FC-68)

(b) Motion Control's Strength Analyzer. This instrument consists of four parts: (1) a clamp loading mechanism; (2) a combing and brushing station; (3) a Length Analyzer for mass measurements, and (4) a Strength Analyzer (1/8" gauge). Each of the parts may be used separately except that the Strength Analyzer cannot be operated independently of the Length Analyzer or mass measuring head. This instrument is neat, compact, performs well, and can prepare and measure 350 beards an hour. Strength measurements are in grams per tex. (FC-69(C))

(c) Solid-State Production Fibrograph (Model 270). This instrument is very compact, attractive in appearance, performs well, has excellent repeatability, is easy to operate and can measure 350 beards per hour. It has both a read-out and a print-out system. Its testing error for the measurement of one beard per sample is as good as that of a measurement of two beards per sample for the Model 230-A Fibrograph. (FC-68)

(d) Solid-State Cotton Fiber Colorimeter. Preliminary evaluation shows that this instrument meets desired specifications and is performing much better than any of the previous cotton colorimeters. Its rate of testing is better than 400 samples per hour. (FC-68)

(e) Development and Evaluation of an Instrument and Techniques for Rapid Determination of Cotton Fiber Strength. The final phase of this work has been completed and the instrument delivered to the Cotton Quality Research Laboratory in accordance with the terms of the contract. This instrument is being evaluated and is now operating in a production-line testing system. The information obtained to date shows that the instrument can function at a speed sufficient to meet marketing needs. One of the major problems encountered is the mass measurement for obtaining the strength value. The use of capacitance for measuring a constant mass is highly affected by relative humidity. This method for measuring mass is being discarded and an "air-gage" is being provided. (FC-69(C))

(f) Development of an Apparatus for Rapidly Mixing and Blending a Sample of Cotton Lint. This apparatus has been received by the Cotton Quality Research Laboratory and evaluation is now underway. Much experimental work will be necessary to determine optimum speeds and settings for producing a desirable test sample. (FC-72)

2. Methodology Studies for Development of Spinning Performance Tests for Cotton. The status and results of studies are summarized below:

(a) 1967 Spinning End Breakage Vs. Yarn Size. Additional work has indicated that twist in yarn should be considered in developing a method for correcting end breakage of the observed yarn size to that of the desired yarn size. Based on the results of some methodology work, using cotton of different fiber properties to spin yarns of different sizes and with different twist multipliers, correction charts were developed for each of several twist multipliers normally used in the Pilot Plant. This method is now being used in all of our work. It is proving to be very reliable and is an improvement over the previous method used. (FC-70)

(b) Methodology of Controlling Fibers in Drafting System. Cotton fibers are controlled by the settings of the drafting mechanism. Results have shown that a 30s yarn should be spun with a tensor opening of $\frac{1}{2}$ millimeter greater than that required to spin 40s yarn from the same cotton roving. Length, length distribution and yarn size are the primary factors determining the settings of the tensor opening for optimum spinning performance. Preliminary experimental data indicates that the setting of the drafting mechanism should be such as to generate a drafting tenacity of approximately 1.2 grams per tex. (FC-101)

(c) Mill Vs. Pilot Plant Study. Results obtained on different cottons spun in two different mills and at the Pilot Plant have shown that each organization ranks the cotton in the same order for processing performance and product quality. In these tests the spinning equipment was set up to give similar drafting tenacity during processing. (FC-101)

3. Measuring Factors Affecting Spinning Performance and Product Quality of Cotton. A mathematical model has been developed for describing the forces on, and motions of, the yarn in the balloon region of a typical ring spinning frame.

Research has demonstrated that the breaking of an individual fiber can be detected by the acoustic pulse generated by the fiber as it breaks. Bundles consisting of a small number of fibers (by count) have been broken and the number of fibers in the bundle showed a good relationship to the number of acoustic pulses generated by the breaking fibers. (FC-71(A))

4. Improvement of Official Cottonseed Standards. A method for determining optimum oil, ammonia and linters factors for use in the cottonseed grading system was developed and presented to the cottonseed crushing industry for consideration at its annual 1968 convention. The new system would make the present official cottonseed grading system more accurate. The American Oil Chemists' Society's Neutral Oil Sub-Committee unanimously recommended the adoption of our new neutral oil determination procedure in the official methods. The method uses redesigned glassware which reduces labor costs and allows the determination to be made in non-air conditioned laboratories. (FC-79)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS AND NATURALLY OCCURRING TOXINS

1. Aflatoxin Production in Cottonseed. Assays of cottonseed samples taken from studies of the effect of maturity and method of harvest (maturity 50% to 100% and machine harvest versus hand harvest) have shown no relationship between the presence or absence of aflatoxins and maturity or method of harvest. In addition, samples of stored seed cotton (1967) failed to develop mycotoxins. Aflatoxin production in stored cottonseed or seed cotton appears to be primarily dependent on the extent and degree of infection prior to harvest by toxin-producing strains of species of the Aspergillus flavus group. Strains of A. parasiticus capable of producing large amounts of aflatoxin have been isolated from cottonseed from the Southwest. (FC-77)

2. Simplified Procedure for the Determination of Aflatoxin B₁ in Cottonseed Meals. Simplification included the following changes: (1) Concentration and purification of aflatoxin fraction on a single column of Celite; (2) the use of a new solvent system (ether:methanol:water (96:3:1)) for the development of aflatoxin fractions on TLC plates; (3) scanning the TLC plates along the entire B₁ front with one setting of the densitometer because of the uniformity of the solvent front; (4) development of a second set of samples on the opposite side of the TLC plates; (5) reducing cost of solvent by use of technical rather than reagent grade of chloroform; and (6) reducing evaporation time of crude extracts from 30 minutes to 10 minutes by using stainless steel beakers instead of glass beakers. (FC-80)

3. Effect of Ambient Storage Conditions on Molds and Aflatoxins in Cottonseed. This is a cooperative study with the Cotton and Cordage Fibers Research Branch, Crops Research Division. Samples are being taken from two storage locations which, while somewhat similar, show little or no aflatoxin at one place and definite contamination at the other. (FC-80)

4. Survey of Growth of Aspergillus flavus and Development of Aflatoxins in Cottonseed. After methods of analysis were standardized for routine assay, about 150 samples were collected in Maharashtra and Andhra Pradesh. The microflora of the seed kernels are being examined by plating delinted and surface sterilized seed on potato-dextrose agar. Initial examination showed the presence of Aspergillus sp., Fusarium sp., Veticillium sp., and two unidentified fungal species. Among the Aspergillus, A. niger was predominant, followed by the A. flavus group. Nine out of ten isolates of A. flavus were tentatively regarded as aflatoxin producers. (FC-97 (A7-MQ-17(k)))

Publications - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

- Chapman, W. E., Mullikin, Robert A., and LaFerney, Preston E. 1968. Quality and performance of Pima S-1 and Pima S-2 cotton under different ginning conditions, El Paso Area, 1964-65. USDA, MRR 803. (FC-65)
- Holder, Shelby H., Jr., McCaskill, Oliver L., and Shanklin, Edward H. 1967. Effects of reclaimed gin-loss cotton on lint quality and spinning performance. USDA, MRR 808. (FC-71(A))
- Newton, Franklin E., Burley, Samuel T., Jr., and LaFerney, Preston E. 1967. Cotton-marketing system: Classification and price as related to use value. Textile Industries and The Cotton Gin and Oil Mill Press, July. (FC-70)
- Perkins, Henry, H., Jr. 1968. A rapid method for determining arsenic residues on lint cotton. Textile Industries, May. (FC-67)
- Turner, John H., Newton, Franklin E., and Whaley, Paul. 1967. Comparison of spinning performances of cottons with varying fiber properties, San Joaquin Valley of California, 1964-65 season. USDA, MRR 793. (FC-65)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

- Graham, John S. 1967. New Spin-Draft Tester. Textile Industries, October. (FC-101)

AREA 8

WOOL AND MOHAIR - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years F.Y. 1968		
	Research Problem Area		Total
	412	501	
Maryland (Beltsville)	0.1	0.1	0.2
Georgia (Insects)	1.1		1.1
Total	1.2	0.1	1.3

Intramural program is supplemented by extramural support representing (a) 1.1 SMYs at State Agricultural Experiment Stations 1/, (b) 0.3 SMYs at other U.S. institutions 2/, and (c) P.L. 480 funds in one country representing 15,100 U.S. dollars equivalent.

1/ RPA 501 1.0; RPA 412 0.1

2/ RPA 412 0.3

Problems and Objectives

Fineness is the most important market characteristic of wool; however, length, crimp, strength, and softness also determine the value of the product. Present methods of determining fineness of wool tops and card slivers are time consuming and must be performed in laboratories. Methods for core bored samples of wool need to be developed. Canary yellow coloration of wool affects approximately 30% of the coarse wool of India and a lesser amount in this country. Losses of manufactured wool products caused by stored-product insects and the cost of their control was estimated to be about \$441.7 million annually for the years 1951-1960. Assuming the projected increase in population of 35% by 1980 will require a similar increase in manufactured wool products, a savings of about \$157 million may be realized in 1980 by reducing losses by 25%, and costs of insect control by 33% through improved control methods.

Major objectives of the research are to:

1. Develop rapid, accurate methods for determining fineness.
2. Evaluate new methods of measuring wool softness and determining relationship between softness and fineness.
3. Determine composition of the pigment causing canary yellow and develop methods for preventing or removing it.
4. Reduce losses to finished wools caused by insects and develop safe mothproofing procedures.

Progress - USDA and Cooperative Programs

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

A. Objective Measurement and Evaluation of Quality

1. Canary yellow coloration of raw wool. The canary yellow pigment was isolated and is believed to consist of three components of different molecular weights. Physical properties (i.e., diameter, medullation, staple length and tenacity) of stained and unstained wools are not different. However, stained fibers do not retain a permanent set as do the white fibers. The staining compound appears to combine with the free amino groups of the wool protein rather than with the carboxyl groups. This combination withstood drastic and degradative conditions of bleaching, but sunlight caused fading. (FC-63 (A7-AMS-12(a)))

B. Prevention of Insect Infestation

1. Nontoxic mothproofing treatments - organophosphorous compounds. Three organophosphorous compounds were the most promising of 25 compounds evaluated as mothproofers. Gardona is of special interest because of its effectiveness and low mammalian toxicity.

In followup studies with Gardona, temperature of the application bath was more important than immersion time or pH. The best protection against insect feeding occurred after treatment in an alkaline bath below 110° F. Exhaustion of Gardona from the bath was rapid. In practical home-type treatments, a bath concentration of 0.01% Gardona in the second rinse satisfactorily protected cloth against black carpet beetle larvae. In initial studies, about 50% of the Gardona applied in the second rinse was recovered on the fabric when concentrations ranging from 0.02 to 0.04% were used.

Application of Bay 77488 at a bath concentration of 0.005% satisfactorily protected woolen cloth against both black carpet beetle and webbing clothes moth larval feeding, regardless of length of immersion, temperature, or pH. To date, there is no satisfactory method for analyzing Bay 77488 residues in woolen cloth.

Bath temperature studies with Ciba C-9491 at a concentration of 0.0025% indicated that a temperature of 75° F. produced the most effective treatment. (SP-55)

2. Nontoxic mothproofing treatments - quaternary ammonium compounds. Five additional compounds, including quaternary ammoniums with intermediate and long alkyl chains, an ammonium saccharinate, and an alkyl isoquinolinium halide were studied. Aliquat 336, a short-chain compound with 8-carbon alkyl groups, remains the most effective quaternary tested.

Aliquat 336 applied to woolen cloth by a sorption treatment at add-ons of 0.15 to 0.50% by weight furnished satisfactory protection against both black carpet beetle and webbing clothes moth larval feeding in precleansing tests and after the residues had aged 9 months.

Cloth treated in a conventional textile padder to contain 0.41% by weight of Aliquat 336 was protected against both insect species before cleansing and after three washings or three drycleanings.

Aqueous spray treatments with Aliquat 336 at 0.6% by weight protected woolen cloth before and after one washing or drycleaning.

Sorption treatment of loose wool by Aliquat 336 at an add-on of 0.42% satisfactorily protected the wool against both carpet beetle and clothes moth larval feeding. Loose wool treated at 0.6% by weight was also satisfactorily protected after carbonizing. Sorption treatment of carpet yarn at 0.42% by weight also satisfactorily protected the yarn against both species.

When Aliquat 336 was applied in the last rinse bowl during raw wool scouring at 0.78% by weight, the wool was satisfactorily protected after scouring, carding, and combing. (SP-13 (C 8898))

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Sample Preparation of Wool for Fineness Determination Using the Coulter Counter Technique. An apparatus has been devised for cutting wool top and grease wool cores into specimens suitable for determining average fineness and fineness variability utilizing the Coulter Counter. The principal advantages are: A means of aligning and holding the wool fibers in shrinkable tubing before cutting; the use of a precision micrometer for advancing the bundles; and the use of readily available double-edge razor blades for cutting the wool. This new system provides the foundation for development of a rapid method for determining fineness of all types of wool samples. (FC-62(C))

2. Interrelationships of Fineness, Softness Quality and Market Evaluation of Domestic Wools. An objective method for the evaluation of softness has been developed. The method repeatedly compresses the wool sample. The interrelationships of the softness, fineness and certain chemical tests are being determined on wool samples obtained from the major wool producing areas of the United States. (FC-62(C))

Publications - USDA and Cooperative Program

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

Objective Measurement and Evaluation of Quality

Gupta, Mrs. K. 1967. Estimation of free sulfur (bromine-oxidizable sulfur) of proteins. Textile Research Journal 37:(5)438. (FC-63 (A7-AMS-12(a)))
 Juneja, K. K., Sule, A. D., and Chipalkatti, H. R. 1966. Estimation of lanthionine content of wool by paper chromatography. Textile Research Journal 36:(11). (FC-63 (A7-AMS-12(a)))

Prevention of Insect Infestation

Bry, Roy E. and Lang, Joe H. 1967. O,O-diethyl phosphorothioate O-ester with phenylglyoxylonitrile oxime (Bay 77488) as a mothproofer of woolen fabrics. Textile Research Journal 37(11):915-919. (SP-55)
 Cohen, E. and Levinson, H. Z. 1968. Disrupted fertility of the hide beetle Dermestes maculatus (Deg.) due to dietary overdoses of biotin. Experientia 24:367-68 (Birkhauser Verlag, Basel (Schweiz)). (SP-40 (A10-MQ-4(a)))

AREA 9

POTATOES - MARKET QUALITY

Handling, Transportation, and Storage

(RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES)

USDA and Cooperative Program

Location of Intramural Work	:	Scientist Man Years, FY 1968
Minnesota	:	1.0
Maine	:	0.2
Maryland (Beltsville)	:	1.0
California	:	0.5
Total	:	2.7

Problems and Objectives

The potato leads all other horticultural crops in terms of tonnage produced. Annual production averages about 15.5 million tons with farm value of about 700 million dollars. It is an important and nutritious food crop. It is being harvested, stored, and transported somewhere in this country every month of the year. Much of the crop is stored for periods from 3 to 8 months with losses during handling and storage averaging about 7 percent. Reduction of deterioration during storage plus improved protection during transportation and terminal market handling could save several million dollars annually.

Major objectives of the research are to develop and evaluate alternative ways for:

1. Providing optimum storage environments.
2. Precutting, curing and storing tuber seed pieces.
3. Transporting potatoes in bulk.
4. Measuring quality objectively and sorting automatically.

Progress - USDA and Cooperative Program

A. Objective Measurement of Quality

1. Texture and turgor measurements. Red Pontiac potatoes stored at 32° and 75° F. for a month were easily distinguishable by measuring the relative frequency of vibration. The large differences in f^2_m values (stiffness coefficient derived from vibrational frequency) indicated that the textures were quite different. Half the potatoes were impacted by a 0.6 lb. weight dropped 20 inches onto each tuber to cause mechanical injury. After holding at 75° F. for 3 days, the discolored tissue in the impact area was carefully cut from the tuber (with a minimum of sound tissue) and weighed. Impacts caused assessable damage to 96% of the potatoes stored at 32° (relatively turgid) and to only 36% of the potatoes stored at 75° (relatively flaccid). Sonic and light transmission measurements on whole potatoes, either immediately or 3 days after impactation, did not correlate significantly with damage as measured by weight of the discolored tissue or differentiate between injured and uninjured tubers. (HC-15)

B. Quality Maintenance in Handling and Packaging

1. Causes and effects of tuber bruising. Injured tubers taken from various stages of the harvesting operation in the Red River Valley and pressure bruised tissues from tubers stored at different depths in a bin were studied histologically. Bruises were not detectable visually when controlled drops or impacts to tubers were 10 inches or less. Tuber size and temperature significantly affected the depth and severity of bruising. Intercellular space determinations showed considerable variation between varieties. (HC-26)

C. Quality Maintenance in Storage

1. Storage of precut seed. Rate of suberization and periderm formation of Red River Valley potatoes was not affected by applications of various concentrations of several fatty acids immediately after cutting. Mercurous chloride inhibited suberization and periderm formation. After a 10-day curing period at 58° F. and 4 weeks' storage at 45° F. and high humidity, seed pieces held without forced air circulation were 80 percent infected with fusarium dry rot. At similar temperature and RH but with an air flow of 5 cfm/cwt. no dry rot developed. Seed pieces cut 1 month after harvest and stored 5 months at 40° F and 85% relative humidity developed dry rot. Varieties varied in susceptibility to dry rot with Red Pontiac developing the most and Kennebec the least. Treatment with maneb provided the best decay control in cut seed. (HC-25)

In experiments conducted in Maine during the 1967-68 season, precut seed was removed from storage in sound dry, decay-free condition after being cured and stored in bulk for approximately eight weeks prior to planting. Experiments with small lots showed better plant stands with less blackleg and seed piece rot in stored, precut seed than in fresh cut tubers. A half carlot of seed stock was successfully precut, cured in bulk, removed from storage with a bulk scoop and shipped by rail to West Virginia for commercial planting. (HC-49)

2. Prestorage and storage treatments for Maine potatoes. Prestorage washing of Katahdins increased lenticel infection in potatoes harvested from dry or moderate moisture soil. When the soil was wet at harvest, differences after storage were not apparent between those pre-washed and those stored as they came from the field. Lenticel infection increased during storage in Kennebecs submitted to prestorage hydraulic stone separation, but Russet Burbanks were not affected. Decay in tubers with about 10% injury from preharvest frost was controlled with air movement of either 1.2 or 3.0 cfm/cwt. of air at 40° F. However, severe pressure bruising developed in the tubers at these air volumes. Washing and re-storing field-frosted tubers after several months of storage improved market appearance. (HC-50)

D. Quality Maintenance During Transportation

1. Mechanical vs. ice-refrigerated rail cars. Potato temperatures in fan-equipped, ice-bunker cars shipped under full-bunker, standard refrigeration and in mechanically refrigerated cars with the thermostat set at 45° F. both averaged about 50° during transit to midwest and east coast markets. Temperatures in mechanically refrigerated cars with a 55° thermostat setting averaged about 60°. The range of temperature between the coldest and warmest positions during transit averaged about 10 degrees in both ice-bunker cars and mechanical cars with either thermostat setting. Average relative humidities were essentially the same in the ice-bunker car and mechanical cars (87% beneath the load and 91% above the load).

There was no appreciable modification of the atmosphere in the ice-bunker cars, but three of the six mechanical cars had carbon dioxide levels of 4.2

to 5.6% at destination. The market quality of White Rose potatoes was good following shipment in either ice-bunker cars or in mechanical cars with thermostat settings at either 45° or 55° F. (HC-33)

E. Postharvest Physiology

1. Storage temperature effects on tuber respiration. Respiration at 60° F. of Katahdin and Irish Cobbler tubers stored up to 6 months at 32° with warming at 60° every third week was consistently lower than that of tubers stored continuously at 32°. The differences were greater with the Katahdin variety than with Irish Cobblers. Katahdin tubers showed blackheart and mahogany browning after 4 months' storage at 32°. Intermittently warmed Katahdin tubers and Irish Cobbler tubers stored constantly at 32° did not show mahogany browning. Differences in respiration of intermittently warmed and continuously refrigerated tubers of both varieties were most pronounced after 6 months' storage. When tubers warmed at 60° were returned to 32°, respiration was lower than that of tubers constantly at 32°. (HC-7)

F. Postharvest Disease Control

1. Losses in potatoes during marketing. About 1.2% of the tubers in samples of Maine Katahdins in the wholesale New York market were unsalable. There was no measurable loss at retail because the tubers had been prepackaged. Trimming losses in consumer samples averaged 3.6%. Bruising, decay, and sprouting were the leading causes of loss.

White Rose potatoes from California showed losses of 1.3% and 1.5% of the pre-packaged wholesale and consumer samples, respectively. Bruising and decay caused nearly all the loss.

In the Chicago market, White Rose potatoes averaged about 9.5% loss from wholesale through consumer level. Most of the loss was due to mechanical injury and greening. Red Pontiac potatoes from the Red River Valley averaged over 10% loss, with about 4% at the consumer level. Fusarium decay was responsible for much of this loss. (HC-19 and 24)

Publications - USDA and Cooperative Program

Objective Measurement of Quality

Findlen, H., and Yeatman, J. N. 1967. Progress on the development of methods of measuring potato chip color. 17th National Potato Utilization Conference Proceedings 1967:52-56. (HC-14)

Finney, E. E., Jr., and Findlen, H. 1967. Influence of preharvest treatment upon turgor of Katahdin potatoes. American Potato Journal 44(11): 383-386. (HC-15)

Quality Maintenance in Handling and Packaging

- Hunter, J. H. and Wilson, J. B. 1967. Effects of static water pressure on potatoes. (Abstr.) American Potato Journal 44(9) (HC-50)
- Johnston, E. F. and Wilson, J. B. 1967. Some studies on prestorage washing of Maine potatoes. (Abstr.) American Potato Journal 44(9) (HC-50)
- Johnston, E. F. and Wilson, J. B. 1967. Effect of soil temperature at harvest time on the bruise resistance of potatoes. (Abstr.) American Potato Journal 44(9) (HC-50)
- Wilson, J. B. and Johnston, E. F. 1967. Studies on feasibility of rehandling to salvage from field frosted potatoes. (Abstr.) American Potato Journal 44(9) (HC-50)

Quality Maintenance in Storage

- Wilson, J. B. and Hunter, J. H. 1967. Extended bulk storage of precut seed potatoes. Maine Farm Research Quarterly. (HC-49)
- Wilson, J. B. and Hunter, J. H. 1967. Storage of fall flumed potatoes. (Abstr.) American Potato Journal 44(9) (HC-50)

Quality Maintenance During Transportation

- Harvey, J. M. and Stewart, J. K. 1968. Shipping tests with White Rose potatoes. California Potatorama 5(3): A-15-16; also published in 1968 Yearbook of Potato Growers Association of California, pp. 46-47. (HC-33)
- Lipton, W. J. 1967. Some effects of low-oxygen atmospheres on potato tubers. American Potato Journal 44:292-299. (HC-33)
- Stewart, J. K. and Couey, H. M. 1968. Chip color of Kennebec potatoes as influenced by field and storage temperatures. Proceedings American Society for Horticultural Science, Vol. 92. (HC-33)
- Stewart, J. K., Kaufman, J. and Burton, C. L. 1968. Temperatures, relative humidity and market quality of early potatoes shipped in ice-bunker and mechanically refrigerated rail cars. Yearbook, Potato Growers Association of California, pp. 55, 57, 59, 61, 63. (HC-33)

Postharvest Physiology

- Hruschka, H. W., Smith, W. L., Jr., and Baker, J. E. 1968. Chilling injury syndrome in potato tubers. Plant Disease Reporter 51(12):1014-1016. (HC-7)

Postharvest Disease Control

- Wilson, J. B. and Johnston, E. F. 1967. Reducing the incidence of bacterial lenticel infection in fall-washed Maine potatoes. (Abstr.) American Potato Journal 44(9) (HC-50)

AREA 10

POULTRY PRODUCTS - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	: Scientist Man-Years F.Y. 1968				
	: Research Problem Area :				
	: 412 :	501 :	702 :	707 :	Total
Maryland (Beltsville)	: 1.0 :	0.5 :	1.0 :	1.5 :	4.0
Georgia (Athens)	: :	:	0.5 :	0.5 :	1.0
	: :	:	:	:	
Total	: 1.0 :	0.5 :	1.5 :	2.0 :	5.0
	: :	:	:	:	

Intramural program is supplemented by extramural support representing
 (a) 0.3 SMYs at State Agricultural Experiment Stations 1/, and
 (b) P.L. 480 funds in one country representing 8,790 U. S. dollars
 equivalent.

1/ RPA 702 0.3

Problems and Objectives

United States farmers sold poultry and eggs valued at \$3.5 billion in 1965, representing 9.1% of total cash farm income. Annually, 8½ billion pounds of poultry are slaughtered under Federal inspection. From this large quantity, millions of pounds are canned or otherwise processed under Federal inspection again. The Federal inspection authorities are confronted by many problems ranging from questions on sanitation in the processing plant to appropriate lighting during inspection for wholesomeness. Since Salmonella-contaminated poultry is an important source of salmonellosis in man, practical means of detecting Salmonella bacteria in poultry products are needed to detect sources of contamination.

Major objectives of the research are to:

1. Obtain information as to sources of Salmonella contamination.
2. Develop rapid reliable methods for detecting and controlling Salmonella.
3. Develop improved procedures and evaluate equipment for effectiveness on maintaining wholesomeness and sanitary quality.
4. Determine the sanitation standards to be used in inspection for wholesomeness.
5. Develop improved procedures or equipment useful in grading.

Progress - USDA and Cooperative Program

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

1. Quality of Chicken Fryers Held in Various Shipping Containers With Either Wet or Dry Ice. Surface bacterial count of fryer chicken carcasses packed in fiberboard or polystyrene foam boxes with either wet ice or dry ice were not significantly different during 9 days at 1°C. At 5°C, significantly lower carcass counts were found in polystyrene boxes with "snow" dry ice than in fiberboard boxes with either wet or dry ice as the coolant. Greater shrinkage of carcasses occurred in boxes with dry ice than in those with wet ice. (FC-132)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Chemical Changes in Egg White During Storage. The lysozyme-ovomucin and the ovomucoid electrophoretic fractions of egg white decreased with time of cold storage. Tyrosine, tryptophane, and

sulphydryl group concentrations increased during storage. Electrical specific conductivity may possibly serve as an index of deterioration of egg white during storage. This measurement was not influenced by the presence of CO₂. (FC-44 (E25-AMS-8(a)))

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS AND NATURALLY OCCURING TOXINS

1. Detection of Salmonella in Poultry and Egg Products. Studies to refine the inverted tube technique for screening Salmonella-negative samples of dried egg and poultry products were continued. A number of laboratories in the United States and in foreign countries are testing this procedure.

The technique using the three-sidearm glass flask has been tested with a variety of poultry and egg products. It has proven dependable for determining Salmonella-negative-samples of all types of poultry products and in markedly reducing the number of presumptive positives that need to be confirmed using the conventional procedures. (FC-40)

2. Reducing Salmonella Contamination of Broiler Chicken Carcasses During Processing. A preliminary brief survey of the incidence of salmonellae at various stations in three broiler processing plants was initiated. A total of 39 separate isolates of Salmonella were made from 3 plant visits and one market survey. Four isolates were obtained from plant surfaces and machinery. Sampling of whole carcasses for Salmonella immediately after the defeathering operation and immediately before packing in ice, yielded a higher than "normal" incidence of positive birds. Studies are being initiated to discover means of reducing fecal--and therefore, salmonellae--contamination during the defeathering operation. (FC-41(A))

RPA 707 - PREVENT TRANSMISSION OF ANIMAL DISEASES AND PARASITES TO PEOPLE

1. Erysipelothrix Infection in Turkeys. Under a cooperative agreement with Oklahoma State University, studies were initiated to determine the effects of vaccination and medication on the non-lesion carrier state of Erysipelothrix insidiosa infection in market age turkeys with the aim of eliminating this state. Results obtained thus far indicate that the route of challenge (method of administration) and the number of organisms are not involved in the production of the carrier state. However, the vaccination status of the turkey does appear to influence the production of this state. No correlation has been found between susceptibility to Erysipelas infection and the sex of the turkey. Since isolations were made chiefly from the digestive tract, it is possible that the carrier state may be a result of re-infection from the environment by an oral route. (FC-43(A))

2. Microbiology of "Further Processed" Turkey Products. In contrast to results reported previously for salmonellae, the percentages of samples yielding coagulase positive staphylococci were about equal for carcasses and raw turkey rolls. Defeathering equipment, particularly spiral type pickers, was an important source of contamination of carcasses with salmonellae and staphylococci. Frequent cleanup of picking machines decreased recoveries of pathogens on further processed products. During further processing operations, work tables, scales, conveyors, knives, cutting boards, presented a high contamination potential. The use of gloves by plant workers resulted in fewer recoveries of staphylococci from further processed products.

The level of general bacterial contamination of raw turkey rolls prior to freezing seldom exceeded 50,000 per gram. Thawed rolls held at 5°C after 3 months frozen storage, exhibited total aerobic counts of about a million per gram within 7 days. Off-odor development, darkening and surface slime began to be evident at this time. Commercially cooked rolls did not show evidence of spoilage until 10 to 14 days after holding at 5°C. Neither staphylococci nor salmonellae were recovered from commercially cooked rolls processed to an end point temperature of 160°F. A heat-resistant strain of Staphylococcus aureus inoculated into turkey rolls did survive laboratory cooking to an end point temperature of 170°F. S. senftenberg 775W was destroyed at temperatures of 160°F and above. (FC-42(C))

3. Bacterial Condition of Commercially Cooked Turkey Rolls. Eastern-type cooked turkey rolls (cooked in aluminum foil and then packaged in plastic casings) were obtained from 3 plants and examined for total aerobes, salmonellae, coagulase positive staphylococci, and Clostridium perfringens during storage at 4.4°C.

Surface contamination of rolls during the first week of storage was generally low with total aerobic counts less than 1,000/cm². Significant increases in count, however, were observed after two weeks with most rolls exhibiting counts of one million/cm² or greater. Surface slime was beginning to become evident at this time. In a number of instances, however, slime was not evident until after 3 weeks of storage even though high counts occurred. Slices removed periodically during storage from stored rolls showed the same pattern of increase in bacterial numbers. Coagulase-positive staphylococci were recovered infrequently and in small numbers. No Clostridium perfringens were detected in any rolls examined. Salmonellae were isolated from 5 of 60 rolls examined. (FC-38)

4. Fluorescent Tracing of Chill Water Intake by Broiler. A dye tracer (Rhodamine B) method was used for observing the routes of water penetration during water chilling of broiler carcasses. Water was shown to localize in the skin mainly in the area of feather follicles and injured surfaces. Penetration through the intact skin to the underlying muscle tissue occurred rarely, and then only during severe agitation. Muscle tissues showing the greatest concentration of dye were those adjacent to body openings made during evisceration. (FC-122)

Publications - USDA and Cooperative Program

RPA 412 - QUALITY MAINTENANCE IN MARKETING ANIMAL PRODUCTS

Mercuri, A. J., Kotula, A. W., and Sanders, D. H. 1967. Low dose ionizing irradiation of tray-packed cut-up fryer chickens. Food Technology 21(11):95-98. (FC-39)

Thomson, J. E., Mercuri, A. J., and Risse, L. A. 1968. Shipping containers for ice-packed poultry. Effect on microbial counts and weights of poultry and ice. USDA, MRR 811. (FC-132)

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICROORGANISMS
AND NATURALLY OCCURRING TOXINS

Banwart, G. J., Mercuri, A. J. and Ryan, T. 1968. Screening method for determining Salmonella-negative samples of dried egg. Poultry Science 47(2):598-603. (FC-40)

Bryan, F. L., Ayres, J. C. and Kraft, A. A. 1968. Salmonellae associated with "further processed" turkey products. Applied Microbiology 16(1):1-9. (FC-40)

RPA 707 - PREVENT TRANSMISSION OF ANIMAL DISEASES
AND PARASITES TO PEOPLE

Sanders, D. H., Thomson, J. E. and Mercuri, A. J. 1968. Quality and intensity of light in judgments of colors encountered in poultry inspection. Poultry Science 47(2):366-371. (FC-45)

AREA 11

TOBACCO - MARKET QUALITY

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years F.Y. 1968				Total
	Research	Problem	Area		
	408	501	702		
North Carolina	0.5	0.5	0.5		1.5
Virginia (Insects)	1.0				1.0
Total	1.5	0.5	0.5		2.5

Intramural program is supplemented by extramural support representing (a) 5.8 SMYs at State Agricultural Experiment Stations 1/ and (b) P.L. 480 funds in one country representing 5,065 U.S. dollars equivalent.

1/ RPA 408 0.5; RPA 501 0.3; and RPA 702 5.0

Problems and Objectives

Tobacco has an annual farm value of more than \$1 billion. In addition, Federal, State and local taxes exceed \$3 billion annually. Fungi and bacteria are partly responsible for the deterioration of agricultural products in transit and storage, but very little work has been done to determine the precise environmental and cultural practices that contribute to storage losses by these organisms. No suitable method for determining the moisture content of tobacco is available for use on the sales floor. Failure to include moisture content in grade standards may result in gross inequities to the buyer or the seller. Losses to leaf tobacco and manufactured products caused by stored-tobacco insects plus the cost of control for the years 1951-1960 were estimated to be about \$13.8 million annually. By reducing losses by 33% and the cost of control by 25% through improved insect control methods, annual savings by 1980 would be about \$4.5 million assuming production remains at the present level.

Major objectives of the research are to:

1. Study the micro-organisms responsible for tobacco deterioration and changes in chemical composition.
2. Develop methods and equipment for rapid determination of moisture content of cured tobacco.
3. Determine the micro-organisms responsible for storage losses of tobacco and how they relate to the tobacco health problem by causing mycotoxicoses.
4. Reduce losses caused by stored-tobacco insects through improved insect control procedures that minimize pesticide residues.

Progress - USDA and Cooperative Program

RPA 408 - QUALITY MAINTENANCE IN MARKETING FIELD CROPS

A. Prevention of Insect Infestation

1. Biology and ecology. Cultures of all stages of the cigarette beetle exposed to 50° F. and 70% R.H. lived for 24 weeks. Others alternated at 4-week intervals between 70° F.-50% R.H. and 50° F.-70% R.H. lived for 32 weeks. Fourth-instar larvae and adults resisted continuous low temperatures longest. Control cultures at 80° F. and 70% R.H. died from a natural toxin within 24 weeks. Insect population was maximum at 12 weeks, then declined in spite of additional medium and larger containers. Eggs and first-instar larvae survived the longest. (SP-16)

2. Improved insecticidal control. Of insecticides evaluated against the adult cigarette beetle, only Accothion and Dursban were effective both as a residual and vapor toxicant.

In vacuum fumigation, acrylonitrile at 4, 6 and 8 lb./1,000 cu. ft. killed cigarette beetle larvae at depths of 5, 7, and 9 inches, respectively, inside compressed tobacco. HCN, at 4 lb., killed larvae at all depths in cases. Acrylonitrile aerated from the tobacco rapidly, whereas HCN aerated slowly.

At atmospheric pressure, 30 p.p.m. of phosphine in air killed all stages of the cigarette beetle in tobacco hogsheads. Phosphine concentrations inside the hogshead and surrounding airspace were similar. The dosage used was 12 aluminum phosphide pellets/1,000 cu. ft. for 96 hours at 80° F. and 60% R.H. At 3- and 6-pellet dosages, some 4th-instar larvae, pupae, and adults survived. (SP-16)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Rapid Method for Measurement of Moisture in Cured Tobacco. A prototype model of an instrument to rapidly measure the moisture content of cured tobacco has been constructed and is being subjected to preliminary testing. The design is based on the relationship between moisture content of cured tobacco leaves and the difference in transmittance values of the leaves at 1.93- and 1.80-micron wavelengths. A $\frac{3}{4}$ " square section of several leaves from a large quantity of tobacco are used for the measurement. Several processors have indicated interest in the meter for use in redrying plants. (FC-50(A))

RPA 702 - PROTECT FOOD SUPPLIES FROM HARMFUL MICRO-ORGANISMS AND NATURALLY OCCURRING TOXINS

1. Microflora of Burley and Dark Air-Cured Tobacco and Their Effects on Quality. A total of 1,091 isolates of micro-organisms were obtained from 11 grades of leaves of dark air-cured tobacco stored in hogsheads for 1 to 5 years. The microflora consisted mainly of Actinomycetes, yeasts, Aspergillus flavus, and bacteria. Aflatoxins produced by seven isolates of A. flavus obtained from dark air-cured tobacco were extracted and identified by thin-layer chromatography. Fractions of extracted aflatoxins, similar to aflatoxin B₁ and G₁ standards, were fatal to developing chicken embryos at low concentrations. (FC-52(C))

2. Microflora of Flue-Cured Tobacco and Their Effects on Quality. Fungi were isolated from 100 samples of nondamaged marketed flue-cured tobacco from 12 different warehouses. Eleven genera were isolated, including ten species of Aspergillus. The fungi isolated from Middle Belt tobacco were Alternaria-40.6%, Aspergillus niger-47.8%, A. repens-38.0%, and Penicillium-25.8%. Old Belt tobacco contained Alternaria-74.0%, Penicillium-52.5%, Aspergillus repens-38.0%, and A. ruber-36.2%. The other genera isolated were Botrytis, Cladosporium, Epicoccum, Fusarium, Mucor, Nigrospora, Rhizopus, and Syncephalastrum. The mean moisture content (wet-weight) was 18.0% for Middle Belt tobacco and 21.6% for Old Belt tobacco.

Four days after inoculations with Aspergillus amstelodami, A. flavus, A. ochraceus, A. repens, A. ruber, and Penicillium sp., mature tobacco leaves were harvested, portions were cultured and the remainder flue-cured. Subsequent harvests and culturing occurred at weekly intervals for 3 additional weeks. Alternaria and Cladosporium were not used as inoculum but were isolated from 95% and 49%, respectively, of the noncured leaves. In contrast, Penicillium sp. and Aspergillus spp. were reisolated from 1.5% and 1%, respectively, of the noncured leaves. After the first two harvest dates, none of the storage fungi inoculated onto the leaves were reisolated from mature noncured leaves. A. repens was most commonly isolated from cured leaf tissue for the first two harvests regardless which of the six fungi was the inoculum. Alternaria was most commonly isolated for the last two harvests.

The fungi growing from 100 samples of damaged and nondamaged tobacco were identified. Aspergillus and Penicillium were commonly isolated from damaged and nondamaged tobacco, whereas Alternaria, Cladosporium, Fusarium, and Rhizopus were more frequently isolated from nondamaged tobacco. The fungi responsible for the damage appeared to be Aspergillus spp. and Penicillium.

The effects of temperature on growth of four genera, including six species of Aspergillus were compared. Generally the aspergilli grew better at higher temperatures than did Alternaria, Cladosporium, and Penicillium. Alternaria grew over the widest temperature range, whereas A. ruber and A. ochraceus had the narrowest range for growth. A. flavus grew better at higher temperatures (32-36° C.) and Alternaria grew better at lower temperatures (12-16° C.).

Results from a preliminary experiment with tobacco inoculated with spores of A. ochraceus and stored for 3 weeks at seven relative humidities ranging from 75-95%, indicate A. ochraceus grows in tobacco at 87% R.H. (33.7% m.c.), but not at 85% R.H. (27.8% m.c.) and below.

Studies on the pH requirements of some of the fungi isolated from moldy tobacco showed that A. ochraceus produced most mycelium at a final pH of 6.0-7.0; A. amstelodami, 3.0-5.0; A. tamaraii, 6.4-8.0; Alternaria, 5.2-7.0; Epicoccum, 5.0-7.0; Penicillium 4.5-6.5; Helminthosporium, 3.0-7.0; Nigrospora, 7.0-8.0. Six thermophilic fungi were isolated from flue-cured tobacco. The most prevalent fungi found in samples of moldy tobacco from Honduras were Aspergillus and Penicillium; those from Turkey were Alternaria, Aspergillus and Penicillium. Significant numbers of bacteria, including Staphylococci, were present on redried leaf and in cigarettes. Identification of bacteria associated with tobacco is underway. (FC-51(A))

Publications - USDA and Cooperative Program

Prevention of Insect Infestation

Childs, Dana P., Overby, James E., and Watkins, Betty J. 1967. Low-temperature effect on cigarette beetle infestations in tobacco hogsheads. Bul. Ent. Soc. Amer. 13(3):205. Abst. (SP-16)

AREA 11b

CUT FLOWERS AND ORNAMENTALS - MARKET QUALITY

Handling, Transportation and Storage

(RPA 906 - CULTURE AND PROTECTION OF ORNAMENTALS AND TURF)

USDA and Cooperative Program

Location of Intramural Work	:		Scientist Man Years, FY 1968
Florida	:	1.0	
California	:	0.5	
Maryland (Beltsville)	:	1.0	
Total	:	2.5	

Problems and Objectives

During the past 5 years the farm value of floral products and nursery stock has exceeded 1 billion dollars each year. Sales are increasing each year but movement of cut flowers could expand much more rapidly if methods of handling, packaging, and vase life extension were available for mass distribution at reasonable prices. Basic research is needed to determine the nature of color changes, water uptake, and ethylene response in cut flowers and applied research must develop optimum storage and transit environments including the usefulness of modified atmospheres.

Major objectives of the research are to develop and evaluate alternative ways for:

1. Extending the market and vase life of cut flowers.
2. Maintaining true flower colors after harvest.
3. Satisfactory opening of flowers harvested as buds.
4. Storing nursery stocks for optimum growth response at planting.

Progress - USDA and Cooperative Program

A. Quality Maintenance in Storage

1. Carnations. California and Colorado carnations cut as buds with 3/4 to 1 inch of color showing and shipped to Washington, D.C., had a vase life after opening at least as long as carnations cut as open flowers. The vase life at 70° F. in tap water was 6 to 7 days versus 11 to 17 days in various preservative solutions. When ethylene levels in storage were near 0.3 ppm or higher, opening of the buds and vase life after 3 weeks' storage at 33° F. were poor; with ethylene levels between 0.1 to 0.2 ppm, opening and vase life were good. Cornell solution (5% sucrose, 400 ppm 8-hydroxyquinoline sulfate (8 HQQ), and 50 ppm silver acetate) was slightly superior to other preservative vase solutions tested to open and to provide a long vase life, especially following storage. Carnation buds loosely wrapped in polyethylene lost 1% or less in weight during shipment from California, and approximately 0.5% during storage for 1 week at 40° or 3 weeks at 33°. (Cooperative with the T&FRD and the University of California at Davis.)

2. Easter lilies. Lilies grown from bulbs previously held 6 weeks at 50° F. in a nitrogen atmosphere produced more blooms and leaves, were shorter, and bloomed later than lilies from bulbs stored in air. The number of blooms was increased about 63%, the number of leaves about 67%, and the time of bloom was delayed an average of 26 days. Similar but less pronounced differences were present in lilies grown from bulbs stored 12 weeks at 32° in nitrogen and in air. Storage at either temperature in atmospheres of 1% oxygen, with or without 5% carbon dioxide, produced results intermediate to those described above. (Cooperative with CRD.)

3. Flowering shrubs. Preservative solutions appear valuable for lengthening the vase life of cut flowers from ornamentals such as forsythia, lilacs, and dogwood. A solution of 2% sucrose, 400 ppm 8-HQC, and 300 ppm "Alar" gave a vase life of 8 to 10 days at 70° F. for each of these flowers, as against only 4 to 5 days in water. (HC-8)

4. Roses. The life of Better Times roses was doubled when kept in solutions of 8-HQC and sucrose. Sucrose closed the leaf stomates and flowers sustained greater fresh weight than controls. 8-HQC increased water uptake by eliminating physiological plugging of the vascular tissue. (HC-71)

5. Gladiolus. Sucrose and 8-HQC combined at 4% and 600 ppm respectively, increased the vase-life of cut gladiolus. This combination produced greater flower fresh weight, more open and larger florets. The effects of 8-HQC and sucrose on gladiolus were increased water uptake and decreased water loss through transpiration.

Gladiolus held for 3 days (simulated shipment) at 40° or 50° F. in polyethylene or paper wrappers showed no differences in opening or keeping ability due to the type of wrapper. (HC-71)

6. Chrysanthemums. Chrysanthemums cut in the bud stage were successfully opened in 8-HQC and sucrose mixtures, in light intensities as low as 100 foot-candles for 8 hours a day after 32° F. storage for 3 weeks. The flowers were of best quality in winter and inferior in spring. Cultivar responses varied widely. (HC-71)

B. Postharvest Physiology

1. Color retention in cut flowers. Better Times roses placed in sucrose solutions kept longer and did not develop blue color like similar roses held in water. This cultivar contains at least 5 pigments, a single anthocyanin and 4 other flavonoids. These flavonoids are derivatives of the flavonol quercetin.

There are 3 anthocyanins common to the chrysanthemum varieties Delaware, Deep Mermaid, and Velvet Ridge. Principal anthocyanin is Cyanidin-3-glycoside. The other 2 anthocyanins are cyanidin derivatives but their glycosidic structures are not known at present. There is a fourth anthocyanin present in Velvet Ridge but it has not been identified. (HC-70)

2. Carnation responses to ethylene. A high incidence of "sleepiness" in commercial shipments of carnation blooms was related to abnormally high concentrations of ethylene gas (100 to 500 ppb) in the atmospheres of shipping containers, load compartments in trucks, and in ambient atmosphere at shipping points in the San Francisco Bay area. Exposure to 125 ppb ethylene for 20 hours at 70° caused "sleepiness" in some blooms and 250 ppb caused the disorder in 100 percent of the blooms. Blooms held dry prior to the ethylene exposure usually were more susceptible to ethylene damage than those in which the stems had been placed in water.

Carbon dioxide concentrations of 7 to 10% substantially reduced sleepiness in blooms exposed to 250 ppb of ethylene. Twenty percent CO₂ was more effective than lower concentrations and caused no injury to the blooms. Exposure to 30% CO₂ caused abnormal color changes and petal injury. The 20% concentration of CO₂ also controlled sleepiness in an atmosphere containing 1,000 ppb ethylene, but lower CO₂ levels did not.

Carnations placed in a solution containing sucrose, ethanol, and N-dimethyl-aminosuccinamic acid for 24 hours prior to exposure to ethylene had slightly less sleepiness than blooms placed in water. This solution also was effective in increasing the vase life of the flowers at room temperature and blooms held in the solution were larger after 2 or 3 days than those held in water.
(HC-34)

Publications - USDA and Cooperative Program

Quality Maintenance in Storage

Hardenburg, R. E., Uota, M., and Parsons, C. S. 1968. Refrigeration and modified atmospheres for improved keeping quality of cut flowers. 12th International Congress of Refrigeration (Madrid, 1967) Proc. Vol. III.
(HC-8)

Uota, M. and Garazsi, M. 1967. Quality and display life of carnation blooms after storage in controlled atmospheres. USDA, MRR 796. (HC-34)

AREA 12

VEGETABLES - MARKET QUALITY

Handling, Transportation, and Storage

USDA and Cooperative Program

Location of Intramural Work	Scientist Man Years F.Y. 1968		
	Research Problem Area		Total
	404	501	
California	2.5	0	2.5
Florida	1.0	0	1.0
North Carolina	0.8	0	0.8
New Jersey	2.0	0	2.0
Illinois	1.0	0	1.0
Maryland (Beltsville)	3.0	1.0	4.0
Total	10.3	1.0	11.3

Intramural program is supplemented by extramural support representing 0.3 SMY at a State Agricultural Experiment Station.^{1/}

^{1/} RPA 404 0.3

Problems and Objectives

Fresh vegetables are essential to good nutrition, but most are highly perishable and during much of the year are marketed at great distances from the area of production. Losses during marketing are particularly heavy for leafy vegetables and tomatoes. Of some 70,000 carlots of head lettuce shipped from western states each year, losses during transit, handling, and retailing are estimated at more than 21 million dollars. Losses during tomato marketing are about the same and millions of dollars worth of melons, sweetpotatoes and celery end up in distress sales or as garbage.

Major objectives of the research are to develop and evaluate alternative ways for:

1. Maintaining quality of mechanically harvested products.
2. Providing optimum transit environment for each commodity.
3. Making objective measurements and sorting by internal quality.
4. Accurate sampling of products in bulk bins.
5. Understanding postharvest physiology and pathology.

RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES

A. Quality Maintenance in Handling and Packaging

1. Ripening of machine-harvested tomatoes for processing. Field-run lots of mature-green to light pink fruits from machine-harvested lots required about 10 days at 68° F. or 8 days at 77° for an 80 to 90% yield of ripe fruits. The machine-harvested fruits ripened faster than hand-harvested fruits from the same fields. Ethylene production by individual fruits was not influenced by method of harvest, but only by stage of ripeness of the fruits. Exposure of unripe fruits to 200 to 400 ppm ethylene for 2 to 3 days hastened ripening. Decay during ripening varied greatly, but averaged about 13%. (Exploratory)

2. Effect of temperature and kind of light source on ripening. Study of tomato temperatures during ripening under several incandescent and fluorescent light sources indicated that fruit temperatures varied as much as 1.6° F. in one test and 0.6° in another. In the first test fruit ripened under continuous incandescent with highest a_L/b_L ratios was also the highest in fruit temperature. Another experiment was conducted to determine the heat rise in red and green fruit under various light sources, including Gro-Lux lamps. Differences in temperature rise of red compared to green fruit under three light sources appear to be slight except for Gro-Lux lamps. Greater differences occurred in temperature rise due to light source. (HC-13)

B. Quality Maintenance in Storage

1. Sweetpotatoes. Large differences in weight and volume losses among varieties developed in storage with considerable consistency for each variety

when compared with the previous year. Pithiness was directly correlated with rapid weight loss, small volume loss, low tissue specific gravity, and high respiration rate. The equation developed in the previous year for predicting pithiness was accurate to within 1 ml. per 100 ml. of volume. Late planting (June) reduced intercellular space at harvest below amounts in earlier plantings. Roots stored at 80° F. did not have as desirable a texture or flavor after 6 or 12 weeks when baked as roots stored at 60°. After 12 weeks of storage pithiness was significantly greater at 80° than at 60° and taste panelists began to note objections associated with pithiness which measured 13.7 ml. per 100 ml. of volume. (HC-52)

2. Storage of mature-green tomatoes in controlled atmospheres. Mature-green tomatoes stored well for 3 weeks at 55° F. in air and several modified atmospheres. However, after 6 weeks' storage, tomatoes in air were almost totally decayed but only 4% were decayed in atmospheres with 3% oxygen with or without 5% carbon dioxide. After one additional week for ripening in air at 65°, the decay in the 3%-oxygen lots had increased to approximately 12%. Decay after 9 weeks at 55° was excessive in all atmospheres tested. Flavor was not impaired in tomatoes held at 55° in atmospheres of 3% oxygen, with or without 5% carbon dioxide, or in air, for periods up to 6 weeks. Some injury was observed in tomatoes from the low-oxygen atmospheres after 6 and 9 weeks' storage at 55° when 5% carbon dioxide was present. The injury was confined to the surface of the fruits.

Mature-green tomatoes ripened almost completely in 3 weeks in air at 55° F., whereas, they remained predominantly green for 6 weeks in atmospheres with 3% oxygen. The addition of 5% carbon dioxide to the low-oxygen atmosphere further retarded ripening. After removal from the low-oxygen atmospheres, tomatoes ripened to a good red color in air at 65°.

A 2-minute dip in 130° F. water after storage in modified atmospheres at 55° did not consistently reduce decay in tomatoes during ripening. (HC-6)

3. Storage of vegetables in reduced atmospheric pressure. Replicated experiments showed that ripening of mature-green tomatoes in atmospheric gas at 65° F. was delayed by decreases in total hypobaric pressure. Decreases in ripening rate were less apparent at hypobaric pressures when oxygen partial pressures were held constant. Treatment effects were objectively measured. Hypobaric storage equipment was improved and storage principles developed. The work indicates that hypobaric vapor pressures will require auxiliary control. (HC-9)

4. Kale. Unwashed bulk kale in bushel baskets with package ice held up well for 4 to 5 weeks at 32° F. or for 1 to 2 weeks at 40°. Kale prepackaged from these bushel baskets into cellophane bags kept well 2 days when placed immediately at 70° or 1 day at 70° after storage. Unwashed kale prepackaged commercially in perforated cellophane bags held up well for 3 weeks at 32° with a shelf life of 1 day at 70°. Unwashed kale kept for 2 weeks at 40° or 5 days at 50° but had no shelf life at 70° following storage. Washing reduced the

storage life of both bulk and prepackaged kale to one half that of unwashed kale. Yellowing of leaves and bacterial soft rot were the main causes of deterioration.

Heat production (respiration) of kale in B.t.u. per ton per day averaged: 5,000 at 32° F.; 8,900 at 40°; 17,100 at 50°; 34,100 at 60°; and 50,900 at 70°. Cutting kale leaves into strips increased respiration rates about 20%. (HC-5)

5. Lima beans. Lima bean pods were injured (rusty-brown spotting and discoloration) by storage for 1 week at temperatures of 32°, 36°, 40° and 45° F. and more seriously by 2 weeks' storage. The brown pod discoloration became much more severe after a day at 70° following refrigerated storage. Fresh lima beans stored even 1 week at 32° to 45° have almost no shelf life on removal because of pod discoloration. (HC-5)

6. Modified atmosphere effects on miscellaneous vegetables. (Cooperative with University of California) Celery. When held for from 4 to 16 days in several combinations of oxygen, carbon dioxide and nitrogen, celery was only slightly benefited by 2 to 4% O₂ and injured by CO₂ above 5%. Optimum refrigeration was of more value for celery than atmosphere modification.

Mushrooms. Atmospheres of 1 to 2% O₂ and 10 to 15% CO₂ slowed cap opening and maintained product appearance compared with air at comparable temperature. Oxygen concentrations below 1% were harmful after 8 days.

Sweet corn. Benefits in retention of sweetness and fresh appearance were obtained under refrigeration with 2 to 4% O₂ and up to 20% CO₂. Off flavors developed in corn held at 1% O₂ or above 20% CO₂.

Cantaloups. Three holding tests with cantaloups indicated favorable response to reduced oxygen and increased carbon dioxide. Atmospheres of 2% O₂ and CO₂ up to 20% were promising for simulated transit periods under refrigeration.

Green peppers. One experiment indicated that development of red color can be retarded by holding in low oxygen but shelf life was not extended.

Garlic. Beneficial effects from storage in 4% oxygen were indicated for long term storage at optimum temperatures. (HC-60A)

C. Quality Maintenance During Transportation

1. Lettuce. Average lettuce temperatures during transit were 36° F. in forced-circulation, nitrogen-refrigerated (N) trailers (Polarstream) and 39° in mechanically-refrigerated (MR) trailers. Average temperatures at various positions within the loads varied by 2° to 3° in both types of trailers, but some freezing occurred in the coldest positions of the N trailers.

Market quality of lettuce from both types of trailers was generally satisfactory at destination. Butt discoloration was slightly less severe and decay was less prevalent at time of arrival in lettuce shipped in the N trailers than that shipped in the MR trailers. The low-oxygen atmosphere in the N trailers also reduced russet spotting.

Paired-car and paired-truck rail trailer shipments of lettuce have been made to compare the quality of lettuce shipped under mechanical refrigeration in air and modified atmospheres with reduced oxygen levels and added carbon monoxide. These tests are still in progress. (HC-32)

2. Celery. Two paired-car test shipments with California celery were made to terminal markets to compare transit temperatures, container damage, and product quality in two different load patterns. The conventional, crosswise, on edge load is being compared with the lengthwise, on edge load. The tests are still in progress. (Exploratory)

D. Postharvest Physiology

1. Effects of field environment on market quality of cantaloups. White-washing the surface of on-the-vine cantaloups exposed to the sun prevented excessive heating of the flesh. The painted fruits and those with a normal cover of leaves reached a maximum of 100° F. 1-2 mm below the surface, whereas untreated fruits exposed to the sun reached 127° F. when the air temperature was 102°. Flesh and cavity temperatures responded similarly, although their temperatures were 5° and 8° lower, respectively, than surface temperatures.

The top half of the melons that were painted white or covered by leaves contained 10% soluble solids at harvest while those that were exposed to the sun and not white-washed contained 9% (difference significant at 95% probability level). No significant difference in soluble solids existed in the lower half of the fruits.

Surface mold and rhizopus rot were more severe in the unpainted, exposed melons than in the others during postharvest holding. (HC-29)

2. Translucent scales of onions. In a 7-day holding test at room temperature with a commercial shipment of Michigan onions, there was a significant reduction in damage by translucent or watery scales with many bulbs decreasing from the moderate and severe injury categories to the slight. The pattern was similar though less pronounced after 38° F. storage.

In a test with translucent or watery scale condition artificially induced by bruising, significant increases occurred in the recovered and slight injury categories and a significant decrease in the moderate and severe injury categories following an 8-week storage period at 38° F. No appreciable benefit was noted from storing treated onions for 2 weeks at 60° prior to storage at 38° for an additional 6 weeks. Storage breakdown did not appear to be significantly affected by the bruising treatment. (HC-20)

E. Postharvest Disease Control

1. Onions. A 2-week curing period in simulated bulk storage with forced heated air at 98° F. and above reduced botrytis neck rot from about 29% in lots without curing to as low as 3% in some curing treatments. Lack of uniform temperatures throughout the pile resulted in some bacterial soft rot development. Weight losses in storage averaged 6.6% for the heat-treated lots and 5.9% for the non-heated.

Cut necks of onions dusted with either 2-aminobutane or ortho 5871, and then inoculated with *Botrytis* spores developed 4.2 and 5.6% decay, respectively, in storage. Untreated lots developed 24% decay. Other chemical treatments were not effective.

Freshly harvested onions, artificially inoculated with *Botrytis allii* spores after they were sprayed in the field with the experimental systemic fungicide DuPont #1991, developed 66% decay after 3 months in storage. When the systemic was applied to the harvested bulbs before inoculation, decay in storage was reduced to 6%. (HC-16)

2. Cantaloups. Treatment of cantaloups with hot water at 135° F. for 30 seconds effectively reduced decay from fusarium rot. Equivalent results were obtained by dipping in a solution of 750 ppm active chlorine or in ziram at 3250. The three best treatments were 250 ppm thiabendazole, 3250 ppm maneb + zinc and 3250 ppm captan. Heat, having the advantage of being residue-free, shows promise as an effective and practical postharvest treatment for control of decay in cantaloups. (Exploratory)

3. Market diseases of Puerto Rican vegetables. The following crops have been investigated for market disorders as they arrive on the Chicago market: apio (10), boniato (16), calabaza (15), chayote (1), ginger (7), malanga (13), ñame (26), yautia (12), and yuca (10). The figure in parentheses indicates the number of organisms isolated from diseased areas that were pathogenic when inoculated into the commodity.

Neither hot water treatments nor chlorine rinses were effective in reducing wastage of these commodities. However, the results of pilot studies, using 1% SOPP and Botran or 1% SOPP and Botran plus a wax coating indicate that these methods may be beneficial in reducing decay of the root crops during storage and transit. (HC-21)

4. Effects of chlorine on vegetable decay organisms. A method was developed for determining the populations of the bacterium *Erwinia carotovora*, which causes bacterial soft rot of vegetables. Populations of 16,000,000 soft rot bacteria per ml of dump-tank and washer water were recorded in a commercial carrot plant and 300,000 per ml in celery hydrocooler water.

The fungicidal effects of the surfactants dodecylbenzene sulfonate (Santomerse F85), alkylphenol ethylene oxide (Sterox NJ), and Octyl polyethoxy ethanol (Triton X100) increased as their concentration increased from 1 to

100 ppm. Polyoxyethylene sorbitan monooleate (Tween 80) had no fungicidal effect. Alternaria tenuis was the test fungus. (HC-40)

5. Role of enzymes in death of vegetable tissue. Potassium nitrate (0.5 M) was more effective in protecting sweetpotato than white potato from maceration by crude enzyme extracted from Rhizopus-rotted sweetpotatoes. The salt provided no protection to white potato tissue and only slight protection to sweetpotato tissue immersed in macerating enzymes from bacterial soft-rotted potatoes.

Protease activity of juice expressed from bacterial soft-rotted potatoes varied with the substrate used and was not correlated with the amount of soft rot. No correlation existed between the ability of a bacterium to reduce triphenyltetrazolium and its soft-rotting ability. No evidence was found to suggest that extracellular phospholipidases are involved in pathogenesis of potato tissue by soft rot bacteria. (HC-10)

6. Identification of market diseases of vegetables. Horseradish. Roots of horseradish stored commercially for 10 months had viable microsclerotia of Verticillium albo-atrum (Verticillium wilt) throughout the vascular ring. The severity of infection and the lack of symptoms at harvest suggest that the fungus proliferates in storage.

Sweet corn. Southern corn leaf blight, caused by the imperfect stage of Cochliobolus heterostrophis, was reported for the first time to be a problem on sweet corn ears on the market. Temperatures between 75° and 95° were favorable for the rapid growth of the pathogen.

Green onions. A hitherto undescribed basal rot of early green onions was found in rail shipments from Arizona. The lesions were of various sizes in the outer scales, gray-black, and had a firm texture and definite margins. Some softening and sloughing off of the infected outer scales was observed. The causal agent, Botrytis allii, is the same as that causing gray mold or neck rot of mature dry onions.

Lettuce. A new market disease of lettuce, referred to by the trade as "San Pablo Blight," is different in appearance from common russet spot, rib discoloration or spotted wilt virus. The symptoms include rusty-tan spots or confluent areas on inner leaves adjacent to normal appearing ribs near the base of the head. It is especially severe on winter-grown Arizona lettuce that is over mature when shipped from areas having unusually heavy rains. The disease develops in transit and may get progressively severe as lettuce moves to eastern markets. No organisms have been cultured from leaves showing typical symptoms.

Carrots. Thielapiopsis basicola (black mold rot) was isolated from infected Texas carrots. Two hundred sound carrots from random market surveys have failed to yield either of the reported black mold rot fungi, T. basicola or Chalaropsis thielavioides.

Geotrichum candidum was easily isolated from several lots of carrots regardless of condition or growing area, indicating the universal presence of this pathogen in carrot soils. The pathogen was also isolated from diseased tissues of honeydew melon, cantaloup, squash (acorn and calabaza), yuca, ñame, sweetpotato and tomato.

Garlic. Symptoms similar to waxy breakdown developed in garlic when held at about 115° F. and above. When held at 75-78°, waxy breakdown symptoms failed to develop, nor did they develop at 70° F. when held in high CO₂ and low O₂ atmospheres. (HC-18 and 23)

7. Losses in lettuce during marketing. During the 1967-68 marketing year, losses of western lettuce in the New York metropolitan area averaged about 17% through the consumer level. Of this total loss, about 8% represented trimming of unusable material at the ultimate use level. Decay, tipburn, and russet spotting caused most of the 4% loss at wholesale whereas bruising and breakage and russet spotting were major causes of loss at retail and by the consumer. In the Chicago market losses over the same period averaged about 19% with a major part of the loss at ultimate use. (HC-19 and 24)

RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS

1. Bulk Bin Sampling of Processing Tomatoes. Eighty bulk bins (800 lb. capacity) were sampled under commercial conditions with 2 dry-type bulk bin samplers to determine any adverse effects caused by the bulk-bin sampling devices. Analysis of the data showed no overall difference between sampling machines. The mean of the two samplers tested showed that sampling outlets caused damage to the tomatoes in excess of the initial drop onto the conveyor and into the refill bins. Tomatoes in the bottom part of the bin, particularly those that were hand harvested, were damaged more than those in upper locations. Mechanically-harvested tomatoes did not show as much damage as hand-harvested fruit because of pre-sorting on the harvester or possibly varietal difference.

Time studies made with the bin samplers showed that major problems were removal and replacement of bulk bins from specified positions in the grower's load. (HC-61)

2. Maturity Separation of Mature-Green Tomatoes. Single-beam spectrophotometer curves of two wavelength pairs (510 and 580 nm, and 580 and 640 nm) were tested to provide separation of immature from mature-green tomatoes. Narrow band interference filters were used in a 4-filter difference meter to measure the differences in optical density [$\Delta OD(510-580 \text{ nm})$ and $\Delta OD(580-640 \text{ nm})$] to separate tomatoes into maturity categories. The ΔOD values for both wavelength pairs were interpreted simultaneously by the instrument operator since a single wavelength pair did not give satisfactory separation. All sorted tomatoes were held at 60° F. for ripening. Size of fruit and variety affected accuracy of sorting and voids in the center of fruits caused erroneous measurement in the immature fruit, but not in mature-green fruit. Where voids are a problem, removal by specific gravity solutions could be used prior to light transmission sorting. (HC-13)

3. Removal of Undercolor Tomatoes from Inspection Sample. Measurement of delayed light emission (DLE) of whole tomatoes was made but since many acceptable fruits were rejected emphasis was redirected to measurement of the fresh juice. As a direct result a new dual-purpose instrument is being built which will measure both the DLE and relative chlorophyll content of a composite juice sample and provide a measure of undercolor tomatoes in the sample. The same sample could be used for the Tomato Color Index (TCI) and *Drosophila* egg detection. (HC-62)

Publications - USDA and Cooperative Program

RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES

Quality Maintenance in Handling and Packaging

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- Lipton, W. J. and Uota, M. 1968. Salvaging of unripe processing tomatoes harvested by machine. USDA, ARS 51-22. (Exploratory)

Quality Maintenance in Storage

- Covington, H. M., Pope, D. T., Kushman, L. J., Nielsen, L. W. and others. 1968. Grow quality sweet potatoes. N. C. Agr. Expt. Sta. Circ. 353. (HC-52)
- Kushman, L. J. and Pope, D. T. 1968. Procedure for determining intercellular space of roots and specific gravity of sweetpotato root tissue. HortScience 3(1):44-45. (HC-52)
- Kushman, L. J. and Wright, F. S. 1968. A new system for curing and storing sweet potatoes. (Abstr.) Association Southern Agricultural Workers 65th Annual Convention Proceedings, p. 166. (HC-52)
- Kushman, L. J. and Wright, F. S. 1968. A new system for storing sweet potatoes. Curing in one room and storing in another with palletized handling, overhead ventilation, and trench heating and humidification. N. C. Agr. Expt. Sta. Tech. Bul. 187. (HC-52)
- Lipton, W. J., Harris, C. M. and Couey, H. M. 1967. Culinary quality of cauliflower stored in CO₂-enriched atmospheres. Proc. American Society for Horticultural Science 91:852-859. (HC-31)
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- Wright, F. S., Splinter, W. E. and Kushman, L. J. 1968. Influence of variety, time from harvest, and storage conditions on mechanical properties of the sweet potato. ASAE Trans. 11(1):81-85. (HC-52)

Quality Maintenance During Transportation

- Stewart, J. K. and Harvey, J. M. 1967. Temperatures, relative humidity and atmosphere composition in a mechanically-refrigerated car and a trailer loaded with lettuce. USDA, ARS 51-13. (HC-32)
- Lipton, W. J. 1968. Low O₂ atmospheres. Benefits and dangers. A report on head lettuce and potatoes. United Fresh Fruit & Vegetable Association Yearbook, pp. 99-100, 103. (HC-32)

Postharvest Disease Control

- Kaufman, J. and Lorbeer, J. W. 1967. Control of Botrytis neck rot of onions by fungicidal dusts and dessicant chemicals. Plant Disease Reporter 51(8): 696-699. (HC-16)
- Kushman, L. J. and Hildebrand, E. M. 1968. Hot-water treatment, a promising control for scurf and black rot of sweetpotatoes. Plant Disease Reporter 52(6):475-477. (HC-52)
- Lipton, W. J., Harvey, J. M. and Couey, H. M. 1967. Conclusions about radiation--USDA team deals with the question "Does gamma irradiation of fresh fruits and vegetables extend their market life?" United Fresh Fruit & Vegetable Association Yearbook, pp. 173-174, 176, 178, 181. (Terminated)
- Spalding, D. H. and Blomquist, M. C. 1967. Macerating action of extracts of Rhizopus-rotted sweetpotatoes as affected by ions. Phytopathology 57:648. (HC-10)
- Wells, J. M. and Stewart, J. K. 1968. Heat pasteurization and chemical fungicides for control of Fusarium rot of California cantaloups. Plant Disease Reporter 52:262-264. (Exploratory)

AREA 13

INSECT CONTROL IN MARKETING CHANNELS - CROSS COMMODITY

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-Years F.Y. 1968			
	Research Problem Area <u>1/</u>			Total
	404	408	412	
Georgia	1.1	13.2	.8	15.1
California	.4	2.0	.4	2.8
Total	1.5	15.2	1.2	17.9

Intramural program is supplemented by extramural support representing (a) 2.0 SMYs at State Agricultural Experiment Stations 2/, (b) 1.8 SMYs at other U.S. institutions 3/, and (c) P.L. 480 funds in two countries representing 262,051 U.S. dollars equivalent.

1/ The SMYs reported in Area 13 are somewhat arbitrarily assigned to RPAs, but the research program and progress statements are not so organized. The technical information developed here is applicable to more than one RPA.

2/ RPA 404 0.2 SMY; RPA 408 1.6 SMY; RPA 412 0.2 SMY.

3/ RPA 404 0.3 SMY; RPA 408 0.7 SMY; RPA 412 0.8 SMY.

Problems and Objectives

Losses caused by stored-product insects in the major susceptible agricultural commodities, and the cost of controlling these insects for the years 1951-1960, were estimated to be over \$1.1 billion annually. The projected overall farm output shows a 60% increase by the year 1980. Assuming the same increase for stored products, improved control treatments that would reduce the losses by 33% and the cost of control by 25% offer a potential savings in 1980 of over \$568.7 million. By developing new measures that leave no objectionable chemical residues and are safer for operators, tremendous benefits will result to which dollar values cannot be applied.

Major objectives are to:

1. Reduce losses caused by stored-product insects.
2. Improve present control procedures.
3. Reduce or eliminate insecticide residues.
4. Develop completely new approaches to insect control.

Progress - USDA and Cooperative Programs

A. Biology, Ecology, Physiology, and Nutrition

1. Mitochondrial metabolism in the Indian-meal moth. Larval mitochondria-oxidized intermediates arising from carbohydrate and protein catabolism at maximal rates were isolated; fatty acids were oxidized to a very limited extent. Oxidation of appropriate substrates was most rapid by mitochondria isolated from fifth-instar Indian-meal moth larvae, but decreased to about 25% of this rate for those from mature sixth-instar larvae. During the same period, the mitochondrial nitrogen in the insect decreased to about 60% of the fifth-instar level. These data indicate that two subcellular mechanisms contribute to the decline in live respiration observed during larval growth. Microscopic examination of isolated mitochondria revealed a classical ultrastructure that was little altered during the growth period. Enzymatic activity decreased in at least one component of the operable shuttle systems capable of transferring reducing equivalents between the cytosol and mitochondria during lipid accumulation. The effect would be to trap reducing equivalents in the cytosol whence they could be used for lipid synthesis. Some evidence suggests that a succinate-potentiated transport of citrate through the mitochondrial membrane could provide carbon to a fatty acid synthetic pathway. The larval midgut ultrastructure contained numerous cytoplasmic fat droplets in the columnar cells, suggesting active uptake of lipid during fatty acid accumulation. (SP-65)

2. Photoperiod studies with the Indian-meal moth. Indian-meal moths emerged in a 24-hour endogenous rhythmic pattern under alternating light-dark cycles. A single light-dark cycle during the pupal stage was sufficient to initiate the rhythm. Response to the light-dark stimulus occurred only after the darkening of the eye pigment in the pupae. The manipulation of the light

conditions to produce rhythmic emergence and maximum synchronization of emerging populations expands the potential for improved control methods. Information on exact time of development and activities of the moths will enable better planning of control measures to increase efficiency and lower costs. In alternating light-dark cycles nearly all oviposition by the moths took place during the dark period. Light was inhibitory but a few eggs were laid during this period. Oviposition varied with density of population. Constant stress and agitation in crowded cultures forced oviposition in the light. Light-inhibited females under stress produced fewer eggs and the viability was low. (SP-66)

3. Humidity and insect behavior. Fourth-instar larvae of O. surinamensis were given two-way choices in relative humidity, light intensity, or both. In darkness, the larvae showed a hygronegative response to a pair of alternative humidities differing by 40%, regardless of the position of the alternative pair on the relative humidity scale. The reaction was most intense at humidities near saturation. It declined to a weak response at 90-50% R.H. and then remained constant to 40-0% R.H. The intensity of the reaction at 100-60% R.H. did not vary at temperatures between 15° and 45° C. The response at 100-60% R.H. was significantly weaker in uniform light than in darkness.

When humidity was uniform, the larvae showed a photonegative response to alternative light intensities. When the dark side of the chamber was moister than the light side, the photonegative response dominated the opposing hygro-negative response at 90-50% R.H. and 70-30% R.H. At 100-60% R.H. the opposing reactions canceled one another.

Tests were run to determine if the antennae are the site of humidity perception. The third (terminal) antennal segment bears a sensory field consisting of a large cone-shaped sensillum and numerous smaller sensilla. Larvae from which the second and third segments of both antennae had been removed no longer responded at 100-60% R.H. It appears, therefore, that one or more of these sensilla mediate the humidity response. (SP-67)

4. Susceptibility of new food product to infestation. BFP-3 (a new wheat-base high-protein food) was tested to see if it could sustain insect infestations. Cigarette beetles, confused flour beetles, and red flour beetles developed in about equal numbers on BFP-3. Indian-meal moth development took 5-6 weeks on BFP-3 and 3-4 weeks on the regular laboratory diet. Total yields of adults from 1,000 eggs were 44 and 73%, respectively. (SP-66)

5. Low temperature adaptation in stored-product insects. Three species of stored-product insects, Tenebrio molitor, Tribolium confusum, and Trogoderma parabile, were acclimated at 15°, 23°, and 30° or 33° C., and then placed in chambers containing an appropriate flour medium at temperatures from 3° to 14° C. After 60 minutes, cold-acclimated insects dispersed more widely in cold temperatures than did warm-acclimated insects. Dispersal was greater at warmer than at cooler temperatures. Large larvae dispersed farther than small larvae of the same species. (SP-17(G8071))

6. Bionomics of Trogoderma. To date 7 species of Trogoderma and 33 related species have been collected from various areas of California. Nearly 5,000 food-sample traps have been placed on 339 properties in northern and south-central California to sample populations present. Results of some life-history studies under controlled conditions are available for T. glabrum, T. inclusum, T. parabile, and T. simplex. Elytral pattern variations have been examined for 3 species to group patterns into broad categories.

Of 540 stock and field samples of suspected diseased Trogoderma larvae, Mattesia trogodermae was diagnosed from 99% of the properties, Adelina tribolii from 6%, and an unidentified Eugregarine from 40%. Over 3,000 specimens were examined. Incidence of M. trogodermae was low in larvae collected from sterile food samples at 22 properties. (SP-18(G8073))

7. Nutrition of almond moth. Comparisons of diets to determine the effects of the protein-carbohydrate ratio on development of the almond moth showed that the optimum levels of protein and carbohydrate for development and reproduction were not the same. Faster development occurred at protein-carbohydrate ratios of 25:65 and 5:85. Maximum survival occurred at a 45:45 level. Females produced the most eggs on a 25:65 diet.

Comparisons of diets to determine the effects of RNA, the amino acids histidine and tryptophane, and sitosterol on development in the almond moth showed that RNA added to the control diet produced the fastest growth rate. The amino acid gave slower development, and sitosterol produced a growth rate similar to the control. Although some larvae on tryptophane developed faster than the control larvae, most developed slower. Sitosterol gave the highest survival rate, followed by RNA. Survival was low on histidine and more so on tryptophane. Females on RNA produced the most eggs. The other diets had reproductive rates similar to the control that included casein, glucose dried yeast, McCollom's salt mixture, wheat germ oil, cholesterol and water.

Evaluation of the role of the B-vitamin complex on larval growth in the almond moth showed that growth was inhibited or mortality was high when thiamin, riboflavin, pyridoxine, Ca pantothenate, folic acid, biotin, or nicotinic acid were individually omitted from the diet. No significant effect was found when p-aminobenzoic acid, choline, inositol, and vitamin B12 were individually reduced in the diet or omitted. No pupation occurred when sterol was omitted from the diet. Adding K_3PO_4 to the diet enhanced larval growth. (SP-23(A8421))

8. Quinones in food of Tribolium confusum. Effects on the confused flour beetle of the synthetic quinones p-benzoquinone and methyl-p-benzoquinone in flour differed at treatment levels of 250, 500, 1,000, and 2,000 p.p.m. (by weight). Both natural secretion and addition of synthetic quinones retarded growth in egg, larval, and pupal stages in proportion to concentration. Fecundity was reduced by natural quinone accumulation and by one of the synthetic quinones. The sexes varied greatly in the effect from quinones, but neither showed a consistent response at any quinone level in growth rate, viability, or sex ratio. (SP-36(A9708))

B. Biological and Physical Control

1. Light. Photoresponse of black carpet beetles in a multichoice phototaxis apparatus agreed in general with spectral sensitivities determined by electrophysiological methods. However, there was a response to red that suggests a receptor other than the eye. Electroretinograms showed the maximum sensitivity of most stored-product insects is in the green region of the spectrum, 5500 Å to 5750 Å. The maximum response of the black carpet beetle adult occurred at about 5250 Å. In most insects tested, retinal sensitivity diminished rapidly above 6000 Å, with virtually no response in the red region of the spectrum. Sex-related differences were observed in the visual response of several stored-product insect species.

A combination of green and ultraviolet light sources in light traps did not attract significantly more insects than did the individual sources. (SP-57)

2. Production of sound by insects. Further extensive listening, recording, and electronic analysis have revealed no sound production by stored-product insects that could be shown to be of biological importance. (SP-57)

An aural method of detecting rice weevil infestation in wheat kernels was explored using piezoelectric transducers and high-gain audio amplifier. Preliminary data from single-kernel listening tests at 80° F., showed that a maximum listening time of 20 seconds per kernel yielded an infestation index that was 53% of the true value as determined by X-ray. Sonographic time-frequency-amplitude analyses revealed identifiable differences between larval and adult feeding sounds. Pupae produced a distinctive sound, but only when physically shocked. Under quiet listening conditions, larvae as early as the second instar were heard. In bulk-kernel listening tests, 1 adult-infested kernel in 800 uninfested kernels could be detected. Preference of single- or bulk-kernel approach will depend on the inspection objective (qualitative or quantitative), the confidence level requirements, and the desired time per test. (SP-63)

3. Effect of sounds on insects. Reactions to sounds have been found in four species. Insects reacted even when shielded from substrate vibration. Cadra cautella and Tribolium confusum reacted consistently, but rather faintly, by jerking the tibiae. Attagenus megatoma and Sitophilus oryzae reacted vigorously by moving their legs and antennae. (SP-21(G9196))

Indian-meal moths mounted on wires perceived sound between 2 and 90 kHz, as evidenced by starting or stopping of flight movements. The stimulus appeared to be mediated by the wire mounts, although free-flying moths took evasive action when tone bursts occurred. The male's behavioral responses to the female pheromone were temporarily inhibited by high-intensity, high-frequency sounds from sources such as loudspeakers, police whistles, or bells. In virgin-female baited traps, the catches normally consisted mostly of male moths. However, 10 kHz sound reduced the ratio of male to female moths caught. (SP-29(A9407))

4. Biophysical research. A cornicular sensillum on the antenna of all larval stages of the saw-toothed grain beetle was identified as a thin-walled chemoreceptor. Electron microscope study of this and surrounding sensilla suggests a primary olfactory guidance function for the cornicle.

Work began on the classification of several types of receptors on the antenna of the Indian-meal moth. Electron micrographs have identified chemoreceptors believed responsible for detection of sex pheromone.

The Savannah insectary strain of the red flour beetle has an apparently non-functional compound eye. Morphological studies have been started to determine the reason for the condition. No differences between blind and sighted beetles were found by light microscopy.

The ocellus of the black carpet beetle was observed to be closely associated with the medial neurosecretory centers of the brain. Further study will determine whether there is a functional relationship.

Pronounced morphological changes have been observed in the midgut of Plodia larvae according to feeding state. A study is under way to determine whether these changes, which may result in larval death or premature pupation, are mediated through neurohumoral or direct neural action.

Electron micrographs indicate the eye of newly-emerged black carpet beetle females is not fully developed. (SP-64)

5. Gamma irradiation. Irradiation of infested wheat flour and cornmeal at a dosage of 30 to 50 krad controlled eggs and young larvae of the red flour beetle, saw-toothed grain beetle, confused flour beetle, almond moth, and Indian-meal moth.

The red flour beetle, saw-toothed grain beetle, and yellow mealworm showed about the same radiation sensitivity as other beetle species that have been studied. The almond moth showed much higher sensitivity to radiation than the Indian-meal moth and Angoumois grain moth had shown in previous studies.

Tests to determine the effects of combined radiation and insecticide treatments have been initiated. Insects were irradiated for various lengths of time before treatment with insecticide. Preliminary results indicate a degree of antagonism when radiation is followed immediately by malathion treatment. At the lowest radiation dosage used, considerably more insects survived the insecticide treatments than survived the insecticide treatment without radiation.

Tests were made to determine the effect of radiation on residues of malathion applied to kraft paper. Two rates of application of malathion and seven radiation levels were used. Preliminary data indicated that the malathion was not significantly affected by the radiation. (SP-58)

Young copulating adult Acarus siro were exposed to gamma radiation. The females laid fewer eggs and hatching time increased as the radiation dose increased from 0 to 50 krad. Egg hatch averaged 9 days for controls and 16 days for irradiated mites. Egg production was reduced 50 and 95% for 5- and 50-krad treatments, respectively.

Introduction of males, previously subjected to 5 to 15 krad of radiation, into normal populations significantly reduced the numbers of all life stages. Females from the 5-krad treatment laid eggs earlier, and total numbers laid during the first 3½ weeks were greater than in the controls. Radiated males (15 krad) released in 10:1 ratio with normal males in an established colony produced no significant reduction in the population. (SP-30(A9408))

6. Host specificity in cereal grains and legumes. Substances in cereal and legume seeds attractive to rice weevils and cowpea weevils, respectively, were found to be water soluble. No repellents for the rice weevil were found in legume seeds, and none for the cowpea weevil were found in cereal seeds. The egg-laying habits of the cowpea weevil were not affected by extracts of legume seeds applied to pea seeds, lima bean seeds, or cereal seeds. (SP-19(G9120))

7. Sex attractants. The effect of radiation on the response of Indian-meal moth males to the female attractant was determined by exposing 3-day-old adults (approximately 25% survival of 8-day-old pupae irradiated with 50 krad) to serial dilutions of extracts from nonirradiated females. Data showed that these males were as responsive and sensitive to the female attractant as were nonirradiated males. Females were irradiated at dosages of 10, 25, and 50 krad as 8-day-old pupae. Adult survivors of the 50-krad dose attracted considerably fewer males than did nonirradiated control females, but they released a material which was still attractive to virgin males. Less difference in attractiveness of treated and control females was observed at 25 krad, and essentially no difference was observed at 10 krad.

Quantitative bioassay indicated that the sex attractant can be extracted from Indian-meal moths with ethanol. Distillation and chromatography are being used in purification and isolation of the attractant. Although some attractant is lost during purification, enough is being isolated for identification.

Electron micrographs of the attractant glands in Indian-meal moths showed few cuticular pore canals. Surfaces of the gland epidermal cells adjacent to the endocuticle were microvillate. Lipid droplets were evident in the gland cells. (SP-31(A9409))

8. Parasite behavior. Bracon hebetor Say, a braconid parasite, was reared in cultures of Indian-meal moth larvae. Addition of 2 adult pairs of the parasite wasps per 200 moth larvae reduced the host population markedly. Use of 7 pairs of wasps reduced the host population even further. Increasing the wasps to 12 pairs made only a slight further reduction in the moth larvae.

Melechares tarsalis (Berlese), a predatory mite, was reared singly, and a complete life history determined at 75% R.H. and 25° C. (SP-33(A9421))

9. Pathogens. Thirty-five pathogenic micro-organisms, including viruses, bacteria, protozoa, and nematodes, have been isolated from stored-product insects. Thirty of these are highly virulent to insects. Certain microsporidian pathogens are relatively host-specific, readily transmitted, and capable of causing high mortality. A new genus and 3 new species of nematodes have been isolated from dried-fruit beetles. These are new host records. The nematodes sterilize adult female beetles and produce high mortality.

A granulosis virus reduced the respiration rate of larvae of the Indian-meal moth. The virus was not effective against other moths tested. The virus was not affected by prolonged periods at 37° C. A formaldehyde egg wash was effective in suppressing the granulosis virus. Larvae exposed to the virus before pupation did not transmit an observable infestation to the following generation. (SP-46)

Adults of Alphitobius diaperinus and Sitophilus granarius were found to harbor representatives of 11 genera of bacteria including Escherichia coli, E. intermedia, E. freundii, Micrococcus sp., Streptococcus sp., Corynebacterium sp., Proteus vulgaris, P. mirabilis, Pseudomonas aeruginosa, Paracolibacterium intermedium, Bacillus sp., Salmonella sp., and members of the Klebsiella-Aerobacter group. Isolated serotypes of E. coli were identified as pathogenic to chickens, calves, and humans. Laboratory tests indicated that lesser mealworm larvae could transmit pathogenic bacteria to food and feed products. (SP-26(A9357))

10. Grain chilling. Saw-toothed grain beetles, Indian-meal moths, and almond moths did not reproduce when held at a temperature of 60° F.

After a 1- and 4-week exposure at 40° F., 30 and 100% mortality of red flour beetle adults, respectively, occurred. After a 4-week exposure at 50° F., 37% of the adults were dead. After 7 weeks' post exposure at 80° F., no progeny were found in media in which the adults had been held at 40° and 50° F. When the adults that were still living after exposure to the various temperatures were placed on new media the number of progeny from those initially exposed 1 week to 40°, 50°, and 60° F. was reduced. This may have been due either to mortality of the adults or exposure to the lowered temperatures. No progeny were found in the media in which the adults were held for 3 or 4 weeks at 60° F., and an average of only 11 and 25 progeny resulted from adults held for 1 and 2 weeks, respectively, at this temperature. (SP-76)

11. Insect-infested soybeans. Previously, insect infestation of soybeans has not been a problem. However, an infestation of the cowpea weevil was discovered in 250,000 bushels of soybeans stored in a metal bin in South Carolina. Seventy samples of the soybeans, averaging 524 g., were returned

to the laboratory for examination. Initially, 0.26% of the soybeans in the samples were found damaged, and adult cowpea weevils averaged two per sample. The samples were held at a temperature of $26.7^{\circ}\text{C} \pm 1^{\circ}$ for 30 days more. After this time 0.54% of the soybeans were damaged, and adult cowpea weevils averaged 15.5 per sample. (SP-77)

12. Physiological control. The efficacy of antivitamin in suppressing weight increase, food uptake, and excretion of hide beetle larvae was greatest with 3-acetylpyridine, less with neopyrithiamine and aminopterine, and least with 4-deoxyripyridoxine. The effect on food use was less in young larvae than in older larvae. Except for 3-acetylpyridine, responses were similar when the same substances were fed to black carpet beetle larvae. This material as well as farnesol and saponin markedly suppressed food consumption.

Attempts were made to counteract incorporation of nutrients in the ovaries by injection of nutrition antagonists into pupae and newly emerged adults. When application was made before ovarian development, egg laying was greatly inhibited by saponin and to a lesser degree with imidazole.

Hide beetle larvae were grown individually and newly emerged beetles were placed in pairs on diets containing known antagonists of pyrimidines, purines, amino acids, sterols, and vitamins, as well as several antibiotics and toxicants, to determine the effects on development and reproduction. Similar studies used adult Mediterranean fruitflies. The action of vitamin overdoses on the hide beetle varied with the life stage. No detrimental effect on larvae was observed from overdoses of nicotinic, pantothenic, or folic acid, or of pyridoxine, biotin, thiamine, riboflavine, choline chloride, or inositol. Overdoses of biotin to adult hide beetles were extremely detrimental. The F_1 generation died out as 1st-instar larvae. (SP-40(A10-MQ-4(a)))

C. Mode of Insecticide Action and Development of Resistance

1. Oxidative detoxification of enzymes. Comparisons on the epoxidation of heptachlor were made between different stages within species and between species of stored-product insects. In Trogoderma parabile the greatest differences in ability to epoxidize heptachlor were found between males and females and between females of two different culture strains. Epoxidation was lower in larval stages than in adults. There were no significant differences between larvae of different ages nor between adult females of different ages. (MQ 1-43(Gr))

2. Resistance to insecticides. Four strains of almond moths collected from Georgia peanut and corn warehouses were tested for resistance to malathion. These strains showed 3.1-, 6.6-, 11.4-, and 12.3-fold resistance to malathion when compared with the susceptible laboratory strain.

Three strains of red flour beetles showed 1.5-, 5.0-, and 84.2-fold resistance to DDT when compared with the laboratory strain. The two strains that showed lower resistance were collected in light traps in old peanut shelling plants in Georgia. The strain most resistant to DDT was collected from bags of floor sweepings from one of these plants. This strongly DDT-resistant strain had only 2.4-fold resistance to malathion. (SP-61)

D. Improved Insecticidal Control

1. Preliminary evaluation. Hoffman and LaRoche RO-5-8019 was evaluated as a synergist for carbaryl against susceptible almond moth larvae to establish a base for comparison with resistant strains. Only about one-third as much carbaryl was required for the LD₅₀ when the synergist was used at a ratio of 5 (synergist) to 1 (carbaryl). The amount of carbaryl combined with the synergist was only about one-twentieth the amount of malathion required for the LD₅₀. (SP-61)

In screening tests of 58 compounds as insecticides against flour beetle adults and black carpet beetle larvae, 23 compounds that seemed promising were further tested to determine their direct-contact, residual, or vapor toxicity to the insects. Twelve of these promising compounds showed one or more of these toxic properties and will be used in subsequent formulation and developmental studies. The chemicals are American Cyanamid 72016, Bay 75546, Bay 78755, Bay 79330, Bay 79845, Bay 80833, Bay 88991, Cela K-159, Mobil MC-1937, Penick SBP1382, Shell SD15568 and Stauffer R-15552. (SP-61)

2. Practical control problems. Field-collected adult white-fringed beetles were exposed to wheat treated with malathion at 8 p.p.m., with malathion-dichlorvos combinations at 8:1 and 8:2.5 p.p.m., and with dichlorvos at 1, 2.5, 4, and 6 p.p.m. for various exposure periods. Malathion at the rate of 8 p.p.m. was not effective against the beetle. Dichlorvos applied at rates of 4 and 6 p.p.m., resulting in an actual deposit on the wheat of 3 to 4 p.p.m., was effective against the adult beetle and prevented oviposition in the grain. Dichlorvos residues on the wheat decreased to only trace amounts within 12 days after treatment.

Adult white-fringed beetles confined on untreated wheat survived 22 days and deposited eggs in grain during the first 10 days. Some of the eggs deposited on dry wheat and held for 2 months were still viable. (SP-61)

Tests were conducted to determine the amount of phosphine residue on soybeans when fumigated with aluminum phosphide according to the Plant Pest Control Division's schedule for cereal leaf beetle control. In replicated fumigations at 45°, 55°, 65°, and 75° F., followed by 48 hours of aeration, the phosphine residues found on the soybeans were, in general, less than 0.001 p.p.m. However, a phosphine residue of 0.04 p.p.m. was found on one sample of the soybeans fumigated at 55° F. There was 100% mortality of caged black carpet beetle larvae and confused flour beetle adults exposed during each fumigation. (SP-61)

Tests were initiated with plywood overpacks of bagged flour, now used by the Armed Forces for overseas shipments, to find treatments that will prevent or control insect infestation of the flour. Overpacks were fumigated with aluminum phosphide pellets as one phase of this study. With a 72-hour exposure at temperatures ranging from 55 to 68° F., fumigation was successful at the commonly recommended rate of 160 aluminum phosphide pellets per 1,000 cu. ft. when applied (1) inside a tightly constructed overpack, (2) inside an overpack covered with a 4-mil polyethylene tarpaulin, and (3) under an overpack covered with a 4-mil polyethylene tarpaulin. Each application produced 100% mortality of five species of caged insects inside the flour bags or in the free space inside the overpacks. Using the technique of placing the pellets under the polyethylene-covered overpacks, additional fumigations were conducted to determine whether a lower rate of application or shorter period of exposure would be effective. Mortality of test insects was 100% when (1) 14 pellets per 1,000 cu. ft. (1 pellet per overpack) were used during a 48-hour fumigation, or when (2) 29 pellets per 1,000 cu. ft. (2 pellets per overpack) were used during a 24-hour fumigation. The temperature in both tests was 70° F. Chemical analyses for phosphine residues on the flour have not been completed; however, analyses of samples from one replicate fumigated at the highest rate of application (160 pellets per 1,000 cu. ft. for 72 hours) showed that phosphine residues did not exceed 0.002 p.p.m. on the flour. (SP-61)

3. Experimental fumigation chamber. An experimental fumigation chamber with controlled environment has been installed at the Savannah laboratory. Operational tests revealed the need for some modifications, adjustments, and minor changes to achieve the required precision of control. These included (1) a larger refrigeration compressor and a change in type of refrigeration gas, (2) an additional modulating valve in the coolant fluid system, (3) addition of more sensitive temperature set-point control instruments, (4) redesign and installation of mountings for the 3-in. diameter specimen probe, (5) construction of housing and installation of a more reliable seal for chamber fan shaft, and (6) addition of a room safety-fan control system. (SP-74)

4. Plant extracts. Comparative studies of the active principles in the leaves of Neem, Melia indica, and Bakayan, M. azedarach show that the bitter constituents belong to the same class of compounds, perhaps nor-triterpenoids. (480 A7-ENT-60(MQ))

E. Insect-Resistant Packaging

1. Evaluation of repellents. Six compounds for potential use on food packages and as grain protectants were tested for repellency to adult flour beetles. Three compounds, all dimethyldithiocarbamates, were equal to or greater than the synergized pyrethrins standard in repellency. (SP-8(C7787))

Of 13 compounds tested for repellency to adult flour beetles, ENT-28740 and ENT-28708 were at least as repellent as the synergized pyrethrins standard.

Polyethylene film impregnated with ENT-25031, a rodent repellent, did not resist penetration by stored-product insects. (SP-59)

2. Residue barriers. Fifteen experimental insecticide formulations or barriers furnished under contract by Battelle Memorial Institute for testing at the Savannah laboratory in an effort to reduce insecticide migration from outside surfaces of treated packages into packaged commodities. These included saran or polyvinyl alcohol to be used as barriers, and coatings in which synergized pyrethrins was combined with paraffin, polyethylene, carnauba wax, or wax combined with ethylene vinyl acetate copolymer. Barriers appearing to have most promise were polyvinyl alcohol or various weights of saran over a thin film of styrene butadiene. Findings have suggested the evaluation of eight different systems which have been prepared by the contractor. (SP-10(C8174))

3. Physical resistance to insect penetration and invasion. Polypropylene/cellophane laminate packets were more resistant to insect invasion than were standard packets but did not prevent insect penetration. Tests with 50-pound bags made with various plies of spunbonded polyethylene and kraft paper showed that the multi-ply bags were more resistant to insect penetration than were single-ply spunbonded or conventional polyethylene bags. A multiwall paper shipping sack with a partly laminated polyethylene inner ply and pasted-open-mouth, stepped-end closures containing dry milk resisted infestation during 6 months' exposure to insects. (SP-59)

4. Storage of piperonyl butoxide-treated kraft papers. Little piperonyl butoxide was lost during 2 years' storage from a mill roll of kraft paper treated with pyrethrins and piperonyl butoxide. Half the treatment migrated within 3 months from the outer treated ply into the inner untreated plies of stored empty multiwall kraft bags. (SP-59)

5. Insect-resistant cotton bags. Extended storage tests to determine the resistance to insect infestation of cotton bags treated with various deposits of synergized pyrethrins, filled with flour, degermed cornmeal or extra-fine cornmeal and exposed to insects for 1 year were concluded. The types of bags tested were: conventional bags with sewn seams; experimental unlined bags with seams covered with treated-kraft paper; and experimental bags with a waxed-kraft liner, cemented longitudinal seam, and sewn-end closures covered with treated-kraft tape. Of the 11 combinations of treatments and constructions, the synergized pyrethrins-treated cotton bag with waxed-kraft liner, cemented seam, and overtaped-sewn ends was as resistant to infestation as was the standard insect-resistant multiwall kraft bag. Residues found in the three dry cereal products stored in the treated cotton bag with waxed-kraft liners were below legal tolerances throughout the test period.

In small-scale laboratory tests greaseproof paper, glassine paper, saran-coated kraft, and saran-coated polypropylene were effective barriers to the migration of piperonyl butoxide from treated cotton into flour. (SP-60)

F. Simplified Residue Analysis

1. Portable gas chromatograph. Analytical methods for use with the portable g-c being assembled under contract were further refined. Iso-octane was superior to benzene as a solvent for extracting residues of insecticides from apples and tomatoes. Better results were obtained from supernatant fluid than from pulp plus liquid. These procedures were not satisfactory for wheat and alfalfa hay. Acetone as a macerating solvent was superior. With the 2 procedures, reproducible levels of residues of aldrin, malathion, heptachlor, heptachlor epoxide, dieldrin, endrin, and DDT were obtained from the 4 commodities. One exception was heptachlor on alfalfa hay. Interference with measurement of heptachlor was overcome by using an organic phase of the mixture for analysis. The portable g-c will be available for demonstration and evaluation by regulatory agencies early in F.Y. 1969. (SP-14(C8901))

2. Rapid extraction and cleanup. An extractor-separator was developed which could be completely automated to proceed through the steps of extraction with proper solvents, and of separation by centrifuging the residues out through the top of the cylinder into a collector ring. Good recoveries were made of less-volatile materials but recoveries of highly-volatile insecticides such as fumigants were poor.

It was also demonstrated that the electrolytic conductivity method of selectively detecting chlorinated hydrocarbons is ideal for use with liquid-solid column chromatographic effluents where the cleanup is accomplished mainly on the liquid-solid column. (SP-12(C8887))

3. Immunological analytical method. Inoculation of rabbits with synthetic insecticide-protein antigens produced antibodies which reacted directly with the protein and the hapten-protein complex. DDA, derived from DDT, and malathion half-ester inhibited agglutination of their respective hapten-protein complexes, and by this method microgram quantities of these insecticides could be determined. Since direct hemagglutination or precipitation could not be obtained with DDA or malathion, inhibition methods will be necessary to use anti-sera for the analysis of the insecticides. Anti-fibrinogen antibodies are stable to freezing and thawing, but anti-hapten antibodies lose their activity after a few days at 4° C. or at -10° C. (SP-11(C8880))

G. Fate and effect of residues. During the past year 3,763 residue analyses were conducted in support of various entomological research programs. Another 808 analyses were conducted under the cooperative study with the Human Nutrition Research Division to determine bromide, chloride, and phosphine fumigant residues in wheat, milling fractions, dough, bread, and rolls to learn the effects of repeated fumigation of stored wheat on quality and nutritional factors.

Methods were developed, adapted, or improved for the analyses of DDT, lindane, pyrethrins, diazinon, fenthion, and Gardona by gas-liquid chromatography. (SP-62)

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AREA 14

INSTRUMENTATION FOR OBJECTIVE MEASUREMENT - MARKET QUALITY

(RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS)

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-years FY 1968
Maryland	5.0
Total	5.0

Intramural program is supplemented by extramural support representing (a) 4 SMYs at State Agricultural Experiment Stations and (b) 1 SMY at other U. S. institutions.

Problems and Objectives

Developments in the marketing and handling of agricultural products demand improved quality-evaluation procedures. Improved instrumentation is needed for measuring moisture content, oil content, texture, maturity, composition, and for detecting defects in a wide range of commodities. An instrument to evaluate only one of these factors in a single commodity can provide a benefit of \$10 million annually and instruments to evaluate each of the factors on all of the commodities can provide benefits exceeding \$500 million annually.

Objectives are to develop instruments and instrumentation methods for rapid analysis of market quality satisfying the needs of the following users:

- (1) Federal-State inspection programs.
- (2) Food handlers and processors.
- (3) Quality control laboratories.

Progress - USDA and Cooperative Program

A. Electrical Properties

Preliminary measurements of electrical properties of apples over the frequency range from 300 M Hz to 1000 M Hz indicate that valid measurements can be made, but results show no definite relationship to any important quality characteristics. (IL-3(G))

B. Light-Transmittance Techniques

1. Oil and moisture measurement of soybeans. The infrared-absorption instrument constructed for measuring the oil and moisture content of soybeans has not provided adequate accuracy. An absorption band not previously noted interferes with the oil determination. It appears this interfering band is associated with the protein content and effort is now being directed toward using the interfering band for protein analysis as well as for correcting the oil analysis. (IL-6)

2. Reflectance standards. A technique using light transmittance has been developed for precise evaluation of the reflectance properties of white powders. This development provides a new means for determining the absolute reflectance of standards for universal use in reflectance spectroscopy. (IL-6)

3. Pigment in flower petals. Spectral absorption measurements on intact flower petals compared with the chemical analysis of the pigments extracted from the tissues show that the pigments in the flower petals are not in the same chemical state as those obtained in the extracts. Therefore, chemical

analysis of extracted pigments can give misleading information on the appearance of the living tissue. Conversely, absorption measurements on intact tissues cannot be used to identify and characterize the pigment concentration. (IL-6)

C. Physical Properties of Pome Fruits

Two methods have been developed for orienting fruit. (1) Flotation in fluid of controlled specific gravity gave orientation on more than 98% of the samples for Jonathan, Rome, and McIntosh apples and Bartlett pears. The accuracy dropped to 85% for Red Delicious apples. (2) A rotating tube gave orientation of more than 95% for Jonathan, Rome, and McIntosh apples and more than 75% for New York Red Delicious but only 50% for Washington Red Delicious. (IL-2(C))

D. Sonic-Resonance Techniques

A sonic-resonance technique has been developed for nondestructive evaluation of the firmness of apples. This measurement shows that the change in firmness during storage is much greater for early harvested apples than for apples harvested at normal harvest time. It appears that apples harvested at optimum time for best eating quality after storage will also retain their firmness better in storage. (IL-6)

Publications - USDA and Cooperative Program

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AREA 15

PIONEERING RESEARCH - MARKET QUALITY

(RPA 404 - QUALITY MAINTENANCE IN MARKETING FRUITS AND VEGETABLES)

USDA and Cooperative Program

Location of Intramural Work	Scientist Man Years F.Y. 1968
Maryland (Beltsville)	3.0
Total	3.0

Problems and Objectives

Fresh fruits and vegetables are still living organisms after harvest and continue many vital processes that involve biochemical and physiological changes and activities. Rate of ripening, aging and susceptibility to disease are factors greatly influencing the storage and marketing life and the quality of fruits and vegetables. Since fundamental processes in the plant tissues in a large measure govern these changes a continuing need exists for more basic information on postharvest physiology, including enzymatic activities, the biosynthesis and function of various natural occurring volatiles, ultrastructure and function of mitochondria including the electron transport chain, the cytochromes, and other factors associated with respiration and its regulation.

The major objective of the research is:

1. Develop fundamental information on the physiological and biochemical changes that occur in fruits and vegetables after harvest.

Progress - USDA and Cooperative Program

A. Postharvest Physiology

1. Precursors of ethylene in ripening fruit. Propanal, which stimulates ethylene production in green tomato slices, was shown not to be a precursor of ethylene, in studies with C-14 labeled propanal. Propionate, a product of propanal oxidation, was found to be more effective than propanal as a stimulator of ethylene production by both green and half-ripe tomato slices. Tracer experiments with C-14 propionate labeled in carbons 1, 2 or 3 did not produce labeled ethylene. Fully ripe tomato slices were not stimulated in their ethylene production. Incorporation of C-14 into ethylene from UL C-14 methionine was increased about 30 percent in the presence of propionate. Propionate appears to stimulate ethylene production in a secondary way in mature green and half-ripe tomatoes. Further studies are aimed at determining whether or not propionate acts as a regulator of ethylene production in metabolism. (PL-1)

2. An enzyme system which produces ethylene. Since the discovery in this laboratory that methionine is a precursor of ethylene, we have been interested in determining the enzymatic system responsible for the conversion of methionine to ethylene. An inactive ethylene forming system prepared from homogenized apple tissue was activated by gel filtration which removed inhibitors. The enzyme, which cleaves methional into ethylene, was purified 200-fold by diethylaminoethyl and carboxymethyl cellulose chromatography and free-flow electrophoresis. The characteristics of this enzyme were studied and it was shown to require both p-coumaric acid and sodium bisulphite as cofactors. In addition, hydrogen peroxide was also necessary as an intermediate in the reaction. Therefore, the enzyme was categorized as a methional peroxidase which resembles the well known horseradish peroxidase. We are currently attempting to further purify this enzyme and establish its activity with methionine. (PL-1)

3. Mode of action of ethylene in relationship to growth regulators. Kinetin at a concentration of 10^{-8} to 10^{-4} M induces ethylene production in 3- or 4-day old pea seedlings, but not in 6-day old seedlings. The increase in ethylene stimulated by indoleacetic acid (IAA) in 6-day old seedlings is further stimulated (doubled) by kinetin. Gibberellic acid, however, has no effect on ethylene production in seedlings at any age. There appears to be an antagonism between the action of ethylene and the action of gibberellic acid on the growth of seedlings. The data accumulated support the hypothesis that ethylene formation in seedlings is directly associated with the important growth regulators kinetin and IAA. (PL-1)

4. Ultrastructure of plant mitochondria. It was firmly established that isolated sweetpotato mitochondria undergo reversible ultrastructural shifts when the concentration of sucrose in the suspending medium is changed. In media containing sucrose at 0.2M, the ultrastructural configuration is similar to that in situ. Increasing the concentration of sucrose from 0.20M to 0.40M results in a progressive condensation of the matrix and dilation of the cristae. Lowering of the sucrose concentration to 0.15M results in damage to the mitochondria and at 0.10M disruption of the mitochondria is essentially complete. The damaging effects of low sucrose concentration can be partially alleviated by including salts such as potassium phosphate in the suspending medium. These results point out the different tonicity requirements for plant mitochondria in comparison to animal mitochondria which retain normal ultrastructural characteristics in media containing sucrose at 0.11M.

In an exhaustive study of the ultrastructure of plant mitochondria, with respect to metabolic state, it was found that the appearance of the mitochondria in the phosphorylating state is identical to that in the nonphosphorylating state. Others have observed that animal mitochondria change from a normal ultrastructural configuration to one characterized by dilated cristae and condensed matrix in the phosphorylating or energized state. These changes have been interpreted by some investigators to reflect conservation of energy by a conformational change in the mitochondrial membranes. These changes might be explained, however, on the basis of ion gradients and resulting osmotic changes due to metabolic movement of ions from one compartment to another. Work in this laboratory with plant mitochondrial systems point to a mechanism of the latter type.

Studies on the development and properties of mitochondria in barley seeds have been initiated in cooperation with A. A. Abdul-Baki of the Field Crops and Animal Products Research Branch. (PL-2)

5. Ultrastructure of fungal spores in relation to the effects of heat treatment. These studies, in cooperation with W. L. Smith, Jr., Horticultural Crops Research Branch, represent part of the effort to characterize stress factors in the study of senescence in plant cells. Germinating spores of Rhizopus and Monilinia were examined under the electron microscope after exposure to heat at 115° and 125° F. for 2 minutes. Rhizopus spores showed immediate derangements in ultrastructure as follows: (1) the ground cytoplasm

tended to aggregate; (2) the mitochondria became distorted and in some cases were disrupted; (3) disruption of the nuclei occurred. In the case of Monilinia, these changes were evident, but to a lesser degree. Distortion of cellular organelles was much more frequent than complete disruption. In all cases, the cell wall was unaffected. (PL-2)

Publications - USDA and Cooperative Program

Postharvest Physiology

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AREA 16

COLOR RESEARCH LABORATORY - MARKET QUALITY

(RPA 501 - IMPROVEMENT OF GRADES AND STANDARDS)

USDA and Cooperative Program

Location of Intramural Work	Scientist Man-years FY 1968
Maryland (Beltsville)	1.0
Total	1.0

Problems and Objectives

Color is an important indication of condition and quality of agricultural products and is an important factor in establishing and applying grades and standards.

Major objectives of the research are to:

1. Measure and define color parameters as a basis for instrument development.
2. Develop color standards for agricultural products.
3. Develop instruments for objective measurement of color in agricultural products.
4. Develop lighting specifications for inspection and grading of agricultural products.

Progress - USDA and Cooperative Program

A. Colorimetry

A new master tomato red tile was created in cooperation with Pemco, Inc., Baltimore, Md. From this master tile 109 new tiles were manufactured and subsequently certified for use by the Department. The Color Research Laboratory certification involves careful spectrophotometric and colorimetric measurement and calculation of Tomato Color Index assigned to each tile. The USDA Tomato Colorimeter must be equipped with a certified tile before it may be used in Federal-State inspection of tomatoes for processing.

B. Gloss Measurement

Measurement of glossiness of food samples (an important grade factor) shows that mode of presentation to the instrument is important.

Re-smoothing of the sample surface was found necessary after each measurement for repeatable results. The texture and color of the product affected subjective evaluation while instrumental gloss measurement was not affected by color of sample.

C. Spectroradiometric Measurement

Measurement of one of the competitive fluorescent fixtures used in inspection showed energy at 630 and 660 nm which affected its spectral quality. Another fixture used widely in inspection did not show color energy at these wavelengths.

Calculations of correlated color temperature and chromaticity coordinates for the fixtures were very close and within tolerances. The significant point then is the dissimilarity of the spectral energy distribution of the lighting fixtures. This makes specification of light source characteristics difficult because of disagreement in defining the term "similarity of spectral curves".

Visual color matching using the lamps in question may resolve the problem; however, visual evaluation can hardly be a criterion for lighting specifications because of the wide variations encountered in human judgment.
(CL-1)

Publications - USDA and Cooperative Program

None.